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# SYSTEMATIC STUDY OF THE GENUS POLYSIPHONIA FROM JAPAN AND ITS VICINITY

TOSHIO SEGI

Faculty of Fisheries, Prefectural University of Mie

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TOSHIO SEGI

Faculty of Fisheries, Prefectural University of Mie

## I. INTRODUCTION

The systematic study of *Polysiphonia* in Japan was made only by the late Prof. K. YENDO, the late Prof. K. OKAMURA and Prof. Y. YAMADA in some degree, as noted below. Since then no one has attempted to study this troublesome genus systematically and nothing has been published except short or fragmentary notes by the Japanese algologists.

For some years the present writer has been studying systematically the Japanese species of *Polysiphonia* under the direction of Prof. Y. YAMADA, in the Botanical Institute, Faculty of Science, Hokkaidō University. In treating this genus the morphological characteristics, especially the position of trichoblasts and scar-cells and the origin of branches in relation to trichoblasts, as well as the outer characters were used in this revision. In the present monographic paper thirty-one species, including nine new species, from Japan and its vicinity (The South Sea Isls., Formosa, Ryūkyū, Kurile Isls., Saghalien) are enumerated. Besides them, there are some species still waiting to be reported until more materials can be obtained.

The writer made an effort to collect as many fresh materials as possible from various places of Japan, but he was obliged to use some dried ones, owing to the War and other obstacles. The Japanese materials used for the present study consist of the specimens belonging to the Hokkaidō University which include the specimens of Prof. Y. YAMADA, Prof. T. TANAKA, Dr. Y. NAKAMURA, Mr. A. KARAKAWA, Prof. M. NAGAI and other algologists, and the Tōkyō University which include the specimens of the lale Prof. K. YENDO, and the herbarium of the late Dr. K. OKAMURA, Prof. J. TOKIDA, Prof. H. HIROSE, Dr. S. ARASAKI, Mr. S. NARITA, and the writer himself. The type specimens are preserved in the Herbarium, Botanical Institute, Faculty of Science, Hokkaidō University.

No genus has been so much mistaken as this genus. Basing on the hitherto described species as *Polysiphonia*, at least more than eighteen genera were established by the various authors. Even recently a new genus, *Enelittosiphonia* has been proposed by the writer. The minute and characteristic species from Japan under the name of *Polysiphonia hakodatensis* YENDO has

graded into this new genus. More than two hundred species of *Polysiphonia* have been enumerated up to the present. In the writer's opinion, however, they are to be combined in much reduced number by careful study.

The writer presumes that some original descriptions were imperfect, and it was unable to get accurate idea in some cases and he wants to study this interesting genus further on. But, if the present paper gives some suggestions to the systematic study of the species of *Polysiphonia*, which abound on the coast of our country, the writer will be much pleased.

Here the writer wishes to express his best thanks to his teacher, Prof. Y. YAMADA, who gave him most valuable suggestions and kind guidance, and who kindly lent many precious foreign specimens. Thanks are also due to Prof. M. HONDA in the Botanical Institute, Faculty of Science, Tōkyō University, who kindly allowed to study YENDO's specimens and to Prof. G. J. HOLLENBERG in the Biological Department, University of Redlands, California, and to Prof. WM. RANDOLPH TAYLOR in the Department of Botany, University of Michigan, and to Dr. E. YALE DAWSON, in the Allan Hancock Foundation, University of Southern California, and to Mrs. ELSA KYLIN, in the Botanical Laboratory, University of Lund, Sweden, who kindly sent him the papers, and to Dr. GEORGE F. PAPENFUSS in the department of Botany, University of California, who kindly allowed the writer to see precious specimens, when the writer visited the University in Berkeley, and to Prof. J. TOKIDA, Dr. S. ARASAKI, Prof. T. TANAKA, Prof. H. HIROSE, Dr. Y. NAKAMURA who allowed the writer to examine their valuable specimens and to Mr. A. KARAKAWA who allowed the writer to see his valuable photographs of specimens belonging to the Herbarium of University of California. The writer is very glad to take this opportunity to express his sincere thanks to Dr. Y. OKADA, the Dean of this Faculty, for affording the opportunity for the present publication.

The expence for collecting materials of the present study was defrayed partly by the subsidy from the Department of Education and partly by the Japan Society for Promotion of Scientific Research, for which the writer must express his best thanks.

TOSHIO SEGI

Professor of Phycology, Doctor of Science,
Faculty of Fisheries, Prefectural University
of Mie, Ōtanimachi, Tsu, Mie Prefecture,
Japan.

July 30, 1951

## II. HISTORICAL REVIEW

The genus *Polysiphonia*[1], the core of the family *Rhodomelaceae*, was established by GREVILLE in 1824[2]. Previously the name *Hutchinsia* had been used for this group of algae by C. AGARDH in 1817[3], 1824[4] and 1828[5], but proved inadmissible because of former application of this name by ROBERT BROWN to a group of the *Cruciferae*. Besides them, more than fourteen other names (viz. *Grammita* BONNEMAISON, *Polyostea* RUPRECHT, incl. *Vertebrata* GRAY, *Dicarpella* BORY, *Gratelloupella* BORY, *Corradoria* MARTIUS, *Grammitella* CROUAN etc.) have been used to designate this group, as listed by SCHMITZ and FALKENBERG in 1897[6] and DE TONI in 1903[7] and 1924[8].

After the works made by LYNGBYE (as *Hutchinsia*, 1819)[9], MONTAGNE (1840)[10] and ZANARDINI (1841)[11], KUETZING described many species of *Polysiphonia* in 1843[12] and listed them in 1849[13], and again gave figures of a hundred and thirty-four ones in 1863[14] and 1864[15]. These figures seem to help considerably foreign students in studying the species of this genus. At the same time NAEGELI's work in 1846[16] and HARVEY's numerous ones in 1846–51,[17] 1847,[18] 1847,[19] 1849,[20] 1853,[21] 1856,[22] 1859,[23] and 1860[24] must be mentioned.

The first systematic arrangement was made by J. AGARDH in 1863,[25] in which he interpreted the genus in a wide sense and divided this genus into four subgenera, namely *Pterosiphonia*, *Herposiphonia*, *Oligosiphonia* and *Polysiphonia*, and enumerated a hundred and nineteen species in all. About this time

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1) The writer adopted the name, *Polysiphonia*, which is most generally used for this group of the algae, although BATTEN and TSENG reported as follows: BATTEN (The Genus Polysiphonia, 1923) reported that "GREVILLE devised the term *Polysiphonia* which has persisted in spite of the indignation of DESMAZIÈRES (1848–51), who was reluctant to abandon the term which had the privilege of seniority, for one 《Que paraît devoir son existence au caprice》". Also TSENG noted (Mar. Alg. Hong Kong, VI, the genus Polysiphonia, 1944) that "GREVILLE also overlooked the earlier published *Vertebrata* S. F. GRAY (1821) referring to the same group of algae. Theoretically, therefore, *Polysiphonia* GREV. is a superfluous name and would be rejected if it had not been legalized in the status of a nomen conservandum by the International Botanical Congress (Briquet, 1935, p. 88)."; 2) GREVILLE, "Fl. Edin. (1824)"; 3) C. AGARDH, "Syn. Alg. Scandinavi. (1817)"; 4) Id., Syst. Alg. (1824); 5) Id., Spec. Alg. vol. 2 (1828). 6) SCHMITZ and FALKENBERG, in ENGLER u. PRANTL's, Nat. Pflanzenfam. (1897); 7) DE TONI, Syll. Alg. vol. 4 (1903); 8) Id., l. c. vol. 6 (1924); 9) LYNGBYE, Hydro. Dan. (1819); 10) MONTAGNE, "Centurie II" (1840); 11) ZANARDINI, "Syn. Alg. Adriat." (1841); 12) KUETZING, Phyc. gen. (1843); 13) Id., Spec. Alg. (1849); 14) Id., Tab. Phyc. vol. 13 (1863); 15) Id., l. c. vol. 14 (1864); 16) NAEGELI, "Polysiphonia (1846)"; 17) HARVEY, Phyc. Brit. (1846–51); 18) Id., Ner. Austr. (1847); 19) Id., Flora Antarct. (1847); 20) Id., Man. (1849); 21) Id., Ner. Bor. Amer. (1853); 22) Id., "Perry Narrat. of the Exped. of an Amer. Scuadr. to the China Sea and Japan, 1852–54 (Washington 1856)"; 23) Id., Charac. of new alg. (Proceed. Amer. Acad. vol. 4 (1859); 24) Id., Fl. Tasm. (1860); 25) J. AGARDH, Spec. Alg. vol. 2 (1863).

he described forty-three species in 1842[1] and studied morphologically in 1879.[2]

Since the study of MARTENS (1866)[3] and GRUNOW (1867,[4] 1874[5]) SURINGAR (1870)[6] reported two new species from Japan, basing on the materials collected by SIEBOLD at Nagasaki. From the morphological point of view, KNY (1873)[7] cleared up the developing process of "Axillarknospen" in several species. In 1878[8] THURET and BORNET gave most excellent artistic illustrations of two European species. After the study of FARLOW (1881)[9], ARDISSONE (1883)[10], KJELLMAN (1883)[11], HAUCK (1885)[12], ASKENASY (1888)[13], BUFFHAM (1888[14], 1893[15]), HARIOT (1891)[16], HOLMES (1895)[17] and DE TONI (1895)[18], FALKENBERG's magnificent work (1901)[19] was a worthy of special attention. He studied especially the structure of the frond from morphological point of view, as well as reproductive organs. At first the genus *Polysiphonia* was delimited clearly by him and summed up by HOLLENBERG (1942, p. 772) as follows: "When first proposed, *Polysiphonia* included practically all of the evidently segmented plants now placed in the *Rhodomelaceae*. As finally delimited by FALKENBERG (1901), *Polysiphonia* included those radially symmetrical members of the *Rhodomelaceae* in which (1) at least the ultimate branches are evidently polysiphonous; (2) most of the branches arise exogenously by a more or less diagonal division of subapical cells before these have cut off pericentral cells; (3) all branches are essentially similar and indeterminate; and (4) only one tetrasporangium is borne normally in each segment."

Afterwards several authors have described new or noteworthy species of the genus. Among these authors the names of BOERGESEN (1902,[20] 1915–20,[21] 1924,[22] 1930,[23] 1931,[24] 1934,[25] 1935,[26] 1936,[27] 1937,[28] 1937,[29] 1939[30]), SETCHELL and GARDNER (1903,[31] 1924,[32] 1925[33]), GEPP (1904)[34], HOWE (1914)[35], YENDO

1) J. AGARDH, Alg. Med. (1842); 2) Id., Florid. Morphol. (1879); 3) MARTENS, Preus. Exped. n. Ost. As. (1866); 4) GRUNOW, Alg. Novara (1867); 5) Id., Alg. Fidschi (1874); 6) SURINGAR, Alg. Japon. (1870); 7) KNY, Axillarkno. Florid. (1873); 8) THURET et BORNET, Etud. Phycol. (1878); 9) FARLOW, Mar. Alg. New Eng. (1881); 10) ARDISSONE, Phyc. Mediter. vol. I (1883); 11) KJELLMAN, Alg. Arc. Sea (1883); 12) HAUCK, Meeresalg. (1885); 13) ASKENASY, Alg. Forsch. "Gazelle" (1888); 14) BUFFHAM, On antheridia(1888); 15) Id., l. c. (1893); 16) HARIOT, Alg. de Yokoska (1891); 17) HOLMES, "New Mar. Alg. Japan. (Journ. Linn. Soc. Bot. vol. 31, 1895)"; 18) DE TONI, "Phyc. Jap. (1895)"; 19) FALKENBERG, Rhodomelac. (1901); 20) BOERGESEN, Faeroes. (1902); 21) Id., Mar. Alg. of Dan. West Ind. vol. 2 (1915–20); 22) Id., Mar. Alg. Easter Isl. (1924); 23) Id., Mar. Alg Canary Isl. (1930); 24) Id., Ind. Rhodophyc. I (1931); 25) Id., l. c. IV (1934); 26) Id., List. Mar. alg. Bombay (1935); 27) Id., Mar. alg. Ceylon (1936); 28) Id., Contri. south Ind. Mar. alg. flora I (1937); 29) Id., l. c. II (1937); 30) Id., Mar. Alg. Iranian Gulf (1939); 31) SETCHELL and GARDNER, Alg. of Northwest. Amer. (1903); 32) Id., New Mar. Alg. Gulf of Calif. (1924); 33) Id., Mar. Alg. Revillagigedo Isl. Exped. (1925) (in Proceed. Calif. Acad. Sci. Fourth series, vol. 19, No. 11); 34) GEPP, Chinese Mar. Alg. (1904); 35) HOWE, Mar. Alg. of Peru (1914).

(1916,[1] 1918[2]), OLTMANNS (1922)[3] and WEBER VAN BOSSE (1923)[4] may be mentioned.

Thanks to the great cytological contribution given by YAMANOUCHI (1906)[5], the life-history of *P. violacea* (ROTH) GREVILLE from Europe became clear for the first time. It proved "haplo-diplobionten" as like as in the Dictyota-type.

The first monographic work, "The Genus Polysiphonia Grev." was published by BATTEN in 1923,[6] in which she divided the genus into two groups, namely Ecorticate species and Corticate ones. One new species and twenty hitherto known species were enumerated.

In 1923–24[7] ROSENVINGE precisely reported the seven species of this genus in every respect. Previously he studied them morphologically in 1884,[8] 1902[9] and 1903.[10] His work is worthy of record in a monument. Then TAYLOR (1928,[11] 1937,[12] 1937[13]), YAMADA (1928,[14] 1933[15]), YAMADA and TANAKA (1938,[16] 1944[17]), LAKOWITZ (1929)[18], OKAMURA (1914,[19] 1929,[20] 1934,[21] 1936[22]), FELDMANN (1931,[23] 1933[24]), FELDMANN and MAZOYER (1937)[25], INAGAKI (1933)[26] and GARDNER (1937)[27] noted a few or more species of this genus respectively.

From the morphological point of view, the excellent work of KYLIN (1907,[28] 1937,[29] 1937,[30] 1941,[31] 1944[32]) must be mentioned. In *P. nigrescens* he clarified the developing process of the reproductive organs. Basing on *P. Morrowii* from Japan and *P. senticulosa* from America, he established a new genus *Orcasia* in 1941.

On the other hand ROSENBERG (1933)[33] studied the origin of trichoblasts,

1) YENDO, Notes on Alg. New to Japan, IV (Bot. Mag. Tōkyō, vol. 30, 1916); 2) Id., l. c. VIII (Bot. Mag. Tōkyō, vol. 32, 1918); 3) OLTMANNS, Morph. u. Biol. Alg. II (1922); 4) WEBER VAN BOSSE, List alg. Siboga, vol. 2 (1923); 5) YAMANOUCHI, The life-history of Polysiphonia violacea, Bot. Gaz. vol. 42 (1906); 6) BATTEN, The Genus Polysiphonia (in Journ. Linn. Soc. Bot. vol. 46, 1923); 7) ROSENVINGE, Mar. Alg. Denmark III (1923–24); 8) Id., Bidrag til Polysiphonia's Morfologi (Rèsume Français) (1884); 9) Id., Ueber die Spiralstellungen der Rhodomelac. (1902); 10) Id., Sur les organs piliformes des Rhodomelac. (1903); 11) TAYLOR, Mar. Alg. Florida (1928); 12) Id., Mar. Alg. Northeast. coast of North Amer. (1937); 13) Id., "Notes on North Atlantic Mar. Alg. I (1937); 14) YAMADA, Mar. Alg. Mutsu Bay, II (1928); 15) Id., Notes on Japan. alg. II (Journ. Fac. Sci., Hokkaidō Imp. Univ. Ser. V, vol. 2, 1933); 16) YAMADA and TANAKA, Mar. Alg. Yonakuni (1938); 17) Id., Akkesi (1944); 18) LAKOWITZ, Algenfl. gesamten Ostsee (1929); 19) OKAMURA, Icon. Japan. Alg. vol. 3 (1914); 20) Id., l. c. vol. 6 (1929); 21) Id., Sōrui Keitō Gaku (1934); 22) Id., Nippon Kaisō Shi (1936); 23) FELDMANN, Contrib. Fl. algol.Algérie (1931); 24) Id., l. c. II (1933); 25) FELDMANN and MAZOYER, Addit. Fl. Alg. mar. l'Algerie (1937); 26) INAGAKI, Osyorowan no Kaisankōsōrui (1933); 27) GARDNER, New Rhodoph. from Pac. coast of North Amer. (1937); 28) KYLIN, Algenfl. schwed. Westkueste (1907); 29) Id., Ana. u. Frucht. bei P. urceolata (1937); 30) Id., Anato. Rhodo. (1937); 31) Id., Calif. Rhodo. (1941); 32) Id., Rhodo. schwed. Westkueste (1944); 33) ROSENBERG, "Rhodomelac. u. Dasyac. (1933)";

pericentral cells and procarps anatomically and established a new family, *Dasyaceae*.

After NAGAI's floral work (1941)[1], HOLLENBERG (1942,[2] 1944[3]) reported the twenty-one species including twelve new species of this genus in the monographic work, considering the anatomical details carefully. It gave valuable suggestions to the systematic study of this genus.

The short monographic paper, "Marine Algae of Hong Kong, VI, The genus Polysiphonia" was published by TSENG in 1944,[4] in which he described six species including two new species and forms.

Lately, the writer (1944)[5], LEVRING (1944)[6] and HOLLENBERG (1945)[7] described a few new species and DAWSON (1945)[8] listed some American species with key for the use of students.

## III. SOME GENERAL REMARKS ON THE MORPHOLOGICAL DETAILS OF POLYSIPHONIA

From the taxonomic point of view, the following characteristics must be taken into consideration: the position of trichoblasts and scar-cells; the origin of branches, whether endogenous or exogenous and whether replacing trichoblasts or not; the character of antheridia; the shape of cystocarps; the nature and origin of rhizoids; the nature of pericentral cells and cortical cells.

### 1. Trichoblasts

The hair-shaped organ which was called at first as "leaves" (NAEGELI, 1846) or "hair-leaves", bears great taxonomic importance, as pointed out by FALKENBERG (1901), ROSENVINGE (1923–24), HOLLENBERG (1942) and other phycologists. In 1903 this important organ was named by ROSENVINGE as "trichoblasts" which is most commonly used.

As a general rule the trichoblasts occur in every species from Japan as far as could be observed, though HOLLENBERG reported the absence of them in a few foreign species. They are rather variable in their quantity on each species. In some species, as *P. obsoleta* SEGI, *P. akkeshiensis* SEGI, *P. tapinocarpa* SURINGAR and *P. yonakuniensis* SEGI etc., they are abundant, but in others they

1) NAGAI, Mar. Alg. Kurile Isl. II (1941); 2) HOLLENBERG, Polysiphonia on the Pac. coast of North Amer. I, Oligosiphonia (in Amer. Journ. Bot. vol. 29, 1942); 3) Id., l. c. II, Polysiphonia (l. c. vol. 31, 1944); 4) TSENG, Mar. Alg. Hong Kong, VI, Polysiphonia (in Papers Michigan Acad. Sci. Arts and Lett. vol. 29, (1944); 5) SEGI, Mar. Alg. Ise Bay, I (Bot. Mag. Tōkyō vol. 58, 1944); 6) LEVRING, "Meeresalg. Crozet-ins. u. Kerguelen, Arkiv. Bot. vol. 31, A (8) (1944); 7) HOLLENBERG, "in Taylor's Allan Hancock Pacific Expedition vol. 12, 1–4, Galapagos Isl. Bahama Isl. (1945)"; 8) DAWSON, An annotated list of the mar. alg. and mar. grasses San Diego country, Calif. (Occas. Papers San Diego Soc. Nat. Hist. vol. 7, 1945)

are sometimes degenerated. According to ROSENVINGE (1923–24) and KYLIN (1937), they are seasonal in their occurrence (cf. p. 241 of this paper).

The trichoblasts arise mainly near the apex of branches of the erect filament, being not found on the creeping intricate one. Commonly they occur near the apex of indeterminate branches, but rarely (as *P. Morrowii* HARVEY) on stichidia which are considered as determinate branches. They arise exogenously and are usually deciduous, but the short ones near the apex of the frond are persistent. In most cases they occur one on each segment continuously, but sometimes (as *P. abscissa* HOOKER et HARVEY, *P. urceolata* (DILLWYN) GREVILLE) they arise irregularly and at intervals of (2)-3-(4) segments apart discontinuously. They arise usually only one per segment, not two of them on it. Most commonly the trichoblasts are arranged in a spiral line running in a counter-clockwise direction towards the tip of the branch, when the branch is seen from the apex. Accordingly it can be called as "spiralling to the left." In *P. novae-angliae* TAYLOR only, however, sometimes it is reversed and in such a case as "spiralling to the right."

The divergence of the trichoblasts is rather constant and sometimes bears some relation to the number of pericentral cells. But originally it is always ¼, sometimes having relation to the branchlets which are intermingled with trichoblasts near the apex of the frond. Even in polysiphonous species (as *P. forcipata* HARVEY, *P. yonakuniensis* SEGI) such divergence (¼) can be seen distinctly near the apex of the filament. In addition, the branches occur in the spirals in the place of the trichoblasts, but the relation of frequency between them is very variable to each other.

The primary axis of trichoblasts is regularly ramified in dichotomous manner, being sometimes simple. Mostly they are branched a few or several times with acute angles in such a manner. The internodes of articulations are shorter downwards in most cases.

The trichoblast is deciduous, but the basal cell remains persistently as an inconspicuous or conspicuous scar-cell at the node between the pericentral cells. The basal cell is small, and as if it formed a roundish lump seen from above, which is clearly distinguished from pericentral cells. Most commonly this cell is situated as only one at the base of trichoblast, but in *P. obsoleta* SEGI two of it on one point of insertion and in *P. pulvinata* J. AGARDH (?) two of it on each node oppositely. In some species the scar-cells give rise to cicatrigenous branches, but in most of them this is not the case. In some foreign species, especially those in whose axils branches arise, they leave no scar-cells.

As pointed out by FALKENBERG (1901), the trichoblasts commonly arise in definite positions. In most of the species of *Polysiphonia* from Japan also the

trichoblasts have a constant characteristic. This fact bears great taxonomic importance as noted above. Sometimes they are arranged rather irregularly, but even in such a case, there is a distinct tendency for the trichoblasts issuing in definite positions.

### 2. Branches

A. Endogenous branches and Exogenous branches

(a) Endogenous branches

Endogenous branches, taking their origin from the central cell of older node, are distinguished essentially from the exogenous ones. Besides such a manner of origin, the character of the basal segment of the branches offers rather distinct criterion for discrimination. In the basal segment of exogenous branches the pericentral cells are reduced in number and they are relatively shorter in length, comparing with other neighbouring segments of the branches. Sometimes it is obscure, but they have often such tendencies as mentioned above.

According to FALKENBERG (1901, p. 55), endogenous branches are divided into two types, Normal endogenous branches and Adventitious branches. The former occur at certain definite positions, having regular sequence. The latter grow endogenously at indefinite positions, bearing no regular sequence in relation to the origin of other branches. Most commonly the endogenous branches are adventitious in *Polysiphonia*, so they do not occur in constant positions, having no regular sequence with respect to the segments. The reproductive organs are often produced on the adventitious branches as may be seen in *P. porrecta* SEGI etc.

In some specimens of *P. Savatieri* HARIOT from Japan, the basal creeping filaments which are rectangularly produced from the stem arise always as endogenous branches (cf. p. 205 of this paper). On this point ROSENVINGE and HOLLENBERG also reported as follows. ROSENVINGE reported that "Endogenous branches produced from the central cell of older joints occur in particular in the species of *Polysiphonia* with creeping shoots and in *Brongniartella*. The creeping shoots always arise endogenously and produce new endogenous shoots; they issue normally near the base of the principal stems in *P. urceolata*, *P. orthocarpa*, *P. atrorubescens* and *P. nigrescens*. In the latter species an endogenous shoot often appears in the axil of the longer branches, near the base of the branch (fig. 393) "(Denmark III, 1923-24, p. 464)." HOLLENBERG reported that "Erect branches arise mostly as assurgent extensions of prostrate branches or exogenously, but they may also arise endogenously from the central cells after the formation of pericentral cells" (Polysiphonia on the Pac. Coast

of North Amer. 1, Oligosiphonia 1942, p. 772).

In *P. senticulosa* HARVEY from Asamushi the new "Langtriebe" arise endogenously (cf. p. 249 of this paper), as noted by KYLIN (Calif. Rhodo., 1941. p. 36). KYLIN interpreted this genus in a narrow sense and established a new genus, *Orcasia* basing on *P. senticulosa* and *P. Morrowii* (from Japan), according to the presence of endogenous branches. But the writer took this genus in a broader sense and classified even their species in *Polysiphonia*. But it does not seem strange if one may put them in other genus.

(b) Exogenous branches

As well as endogenous branches, exogenous branches are also distinguished in two types, Normal exogenous branches and Cicatrigenous branches (HOLLENBERG, 1. c. p. 722). The former occur directly from branch primordia cut off from subapical cells. The latter arise from scar-cells which remain as persistent basal cells of trichoblasts after the drop of them. According to ROSENVINGE, however, in some foreign species sometimes they occur from basal cells earlier before the drop of them (1. c. p. 464). In addition, ROSENVINGE called Cicatrigenous branches as "Adventitious shoots" or "Secondary axillary shoots." In *Polysiphonia* all trichoblasts occur exogenously, so all cicatrigenous ones are indirectly exogenous.

B. Determinate branches and Indeterminate branches

From the developmental point of view, branches are divided into two types, Determinate branches ("Kurztriebe") and Indeterminate branches ("Langtriebe") by FALKENBERG in Rhodomelac., 1901. The former are simple and show limited growth. The latter grow unlimitedly. In *Polysiphonia* all branches are essentially indeterminate, though in some species ultimate branches are usually more or less determinate.

C. Origin of branches

Exogenous branches rather constantly occur near the apex of the frond, having a close relationship to the trichoblasts. They are arranged in a spiral line, sometimes being intermingled with trichoblasts. In respect to the origin these two organs are homologous to each other.

In every Japanese and some foreign species the entire primordium becomes the branches directly, but in the other foreign ones the primordium is divided into two forks and commonly the outer fork develops into a trichoblast and the inner one into a branch. Accordingly the former is called by foreign phycologists as "not in connection with trichoblasts" (replacing trichoblasts) and the latter as "in connection with trichoblasts" respectively. The writer designates these two kinds of branches as "Trichoblast-unconnecting branches" and "Trichoblast-connecting branches." They bear important taxonomic

significance, and this difference is one of the most striking feature for separating the one species from the other.

(a) Trichoblast-unconnecting branches

In every Japanese species at hand, the branches do not come out in connection with trichoblasts in their origin, as far as could be observed. That is to say, they are independently issued and bear no relationship to the trichoblasts in origin. Such branches arise directly from the youngest segment under the apical cell and commonly in the place of a trichoblasts arranged in the spiral. In some species the segments which produce the branches are higher than those which give rise to the trichoblasts, as pointed out by ROSENVINGE (l. c. p. 463).

As noted above, in the Japanese species the branches do not arise in connection with trichoblasts in origin while in many foreign species this is not the case (see the following term (b) Trichoblast-connecting branches). Judging from the external appearance alone, *P. Tokidae* SEGI, *P. Yendoi* SEGI, *P. nipponica* SEGI, *P. akkeshiensis* SEGI, *P. yonakuniensis* SEGI, *P. porrecta* SEGI and *P. notoensis* SEGI show much resemblance to *P. sertularioides* (GRATELOUP) J. AGARDH, *P. fibrata* (DILLWYN) HARVEY, *P. fibrillosa* GREVILLE, *P. violacea* (ROTH) GREVILLE, *P. opaca* (C. AGARDH) ZANARDINI, *P. variegata* (C. AGARDH) ZANARDINI and *P. cancellata* HARVEY respectively. Following to the difference of the origin of branches, however, these Japanese species are distinguished from foreign ones most clearly.

(b) Trichoblast-connecting branches

In some foreign species the branches do not show such a characteristic as mentioned above. They arise in the axils of trichoblasts, connecting the trichoblasts in the origin. Their basal cells are entirely in common with those of trichoblasts, as pointed by FALKENBERG, ROSENVINGE, KNY and other various authors. The writer also ascertained this important characteristic in some French and British specimens and figured these trichoblast-connecting branches in Text-fig. 1. In Addition, the "trichoblast-connecting branches" are called by foreign phycologists as "Achselproducte" (FALKENBERG, Rhodomelac. 1901), "Axillary buds" (ROSENVINGE, Denmark III, 1923–24), or "Axillarknospen" (KNY, Axillarkno. Florid., 1873).

On this interesting question, ROSENVINGE reported that "In the other species of *Polysiphonia*, in *Brongniartella byssoides*, *Chondria dasyphylla* and *Laurencia pinnatifida* the normal branches arise as axillary buds of the trichoblasts. In *Brongniartella* they arise rather late when the trichoblast has reached a pluricellular stage. In *Polysiphonia* they arise much earlier, simultaneously with the trichoblast or nearly so, and it seems that the branch-

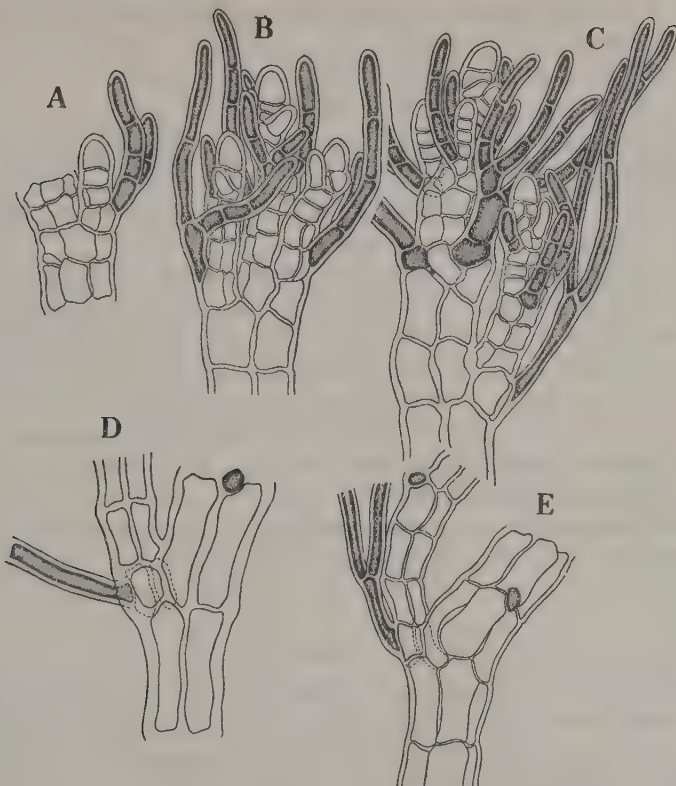



Fig. 1. A–C. *Polysiphonia violacea* (ROTH) GREVILLE. ×ca. 375. Tip of the branch bearing the "trichoblast-connecting branch." The specimen from Atlantic coast of France; D. *Polysiphonia fibrata* HARVEY. ×ca. 175. Upper part of the branch bearing the "trichoblast-connecting branch." The specimen from Clare Island, Ireland; E. *Polysiphonia fibrata* HARVEY. ×ca. 175. Upper part of the branch bearing the "trichoblast-connecting branch." The specimeu from Durlstone Head, England.

producing trichoblasts are, at their first appearance, bigger than the sterile ones (comp. K. R. 1884, p. 29, rés. p. 5, figs. 34–40). The branches in *Polysiphonia* are thus not branches of the trichoblasts as OLTMANN's thinks (Morph. u. Biol. d. Alg. 1904, p. 609). The basal cell common to the trichoblast and the branch belongs as to its lower-most part to the stem. The first joint of the branch, common with the trichoblast, cuts off pericentral cells on its outer surface, but the central cell of this joint keeps the protoplasma continuity with the trichoblast through a longitudinal wall between the pericentral cells or the

segmental wall between the first and the second joint (figs. 379, 388, comp. K. R, 1903, p. 468)". (l. c. p. 463).

### 3. Antheridia

The nature of the antheridia is one of rather important characteristics. The antheridia arise usually as a primary branch of trichoblasts, but sometimes, as in *P. senticulosa* HARVEY(?), they occur on the simple trichoblasts themselves, covering the lower part of them.

The antheridia bear most commonly short sterile tips composed of one cell at the apex of them. In some species (such as *P. akkeshiensis* SEGI, *P. senticulosa* HARVEY (?)), however, they have long sterile tips, composed of several cells. Such antheridia as the latter case are rather peculiar in case of *Polysiphonia* from Japan. At the base they are supported by usually a two-celled stalk. The antheridia are usually simple, being never ramified as far as could be observed, though ROSENVINGE observed only once the ramified antheridia in *P. urceolata* (l. c. p. 409).

Most commonly they are formed only one on each trichoblast, but rarely (as *P. obsoleta* SEGI) two of them are produced on the same trichoblast seriately.

### 4. Cystocarps

The importance of reproductive organs is entirely neglected by HOLLENBERG. In the writer's opinion, however, the shape of cystocarps is considerably important in the classification of the species of *Polysiphonia*. It is rather variable in its shape, but there is often a distinct tendency to have its definite configuration. Commonly it is urceolate, but sometimes ovate or globose, having its own characteristic in shape.

The procarp usually occurs on the second segment of the female trichoblasts but sometimes arises from the second segment of branches besides trichoblasts (as *P. obsoleta* SEGI).

### 5. Rhizoids

The rhizoids occur usually near the base of the frond, but sometimes on the upper and middle parts of it. They are produced as outgrowths of the corner or centre of the pericentral cells in the ecorticated species, but in corticated ones they are issued as outgrowths of cortical cells. In some species they arise at the middle part of the branches, connecting each branches (as *P. forcipata* HARVEY, *P. porrecta* SEGI). Rarely the rhizoids arise in the axis of branches. In the species having a discoid base the rhizoids are densely ag-

gregated on this part (as in *P. japonica* HARVEY). In *Polysiphonia* the rhizoids are commonly unicellular and simple, but sometimes they are ramified near the end (as *P. notoensis* SEGI, *P. decumbens* SEGI) or the base (*P. Savatieri* HARIOT). Sometimes they are provided with a discoid hapter at the end, but sometimes not so. In the origin the first rhizoids arise from the lowermost cell of the plant (*P. notoensis* SEGI). The next are produced from the first node which does not produce pericentral cells, according to ROSENVINGE (l. c. p. 434, fig. 384; p. 442, fig. 396).

The rhizoids are sometimes separated from the pericentral cells by cross walls, but sometimes not so. It is noticeable whether the rhizoids are cut off by cross walls or not. In some cases, however, it is too difficult to distinguish them clearly. It is not rare that both cases can be seen on the same plant.

### 6. Pericentral cells and cortical cells

In the tetrasiphonous species of *Polysiphonia* the number of pericentral cells is usually quite constant throughout the frond, while in the polysiphonous species it is often changeable in the number of them and commonly diminishing in its number upwards. In *P. porrecta* SEGI only, however, the pericentral cells in the lowermost part of the frond are lesser than those of the upper part of it. In *P. codiicola* ZANARDINI the writer has met with four pericentral cells being connected transversely with a central axial cell by plasma in the cross section near the basal part of the frond, and in *P. subtilissima* MONTAGNE he has observed many pericentral cells being connected longitudinally with their neighbouring ones by plasma seen from above.

In the transverse section, the tetrasporic frond usually bears two more pericentral cells than those of the vegetative frond, according to the formation of "Deckzellen." The excellent morphological studies on the tetraspores have been given by FALKENBERG and ROSENVINGE. The tetraspores seem to be produced from pericentral cells. The character of the tetraspores is not so much desirable for the taxonomic purpose as the other characters mentioned above.

The cortical cells arise from the corner of the pericentral cells. Commonly they are present only near the base of the frond, but sometimes they are distributed throughout the frond (as in *P. crassa* OKAMURA).

## IV. AN ANALYTICAL KEY TO THE JAPANESE SPECIES OF POLYSIPHONIA

1. Plants with 4 siphons (*Oligosiphonia* J. AG.) ········· 2
1. Plants with more than 4 siphons (*Polysiphonia* J. AG.) ········· 3
   2. Fronds ecorticated ········· 4
   2. Fronds corticated ········· 5
4. Trichoblasts or scar-cells arising continuously one on each segment ········· 6
4. Trichoblasts or scar-cells not as above ········· 7
   6. Trichoblasts well developed ········· 8
   6. Trichoblasts not as above ········· 9
8. Fronds thick, robust, high and articulations shorter than diam. ········· *P. Kampsaxii* BOERG. (P. 183)
8. Fronds and articulations not as above ········· 10
   10. Branchlets paniculate and cystocarps globose ········· *P. codiicola* ZANARD. (P. 186)
   10. Branchlets not paniculate and cystocarps narrow ovate ········· *P. obsoleta* SEGI (P. 188)
9. Fronds shortly fibrillose, very flaccid, pale-grey ········· *P. Tokidae* SEGI (P. 192)
9. Fronds not as above ········· 11
   11. Fronds small ········· 12
   11. Fronds elongated ········· 13
12. Branchlets corymbose ········· *P. pulvinata* J. AG. (?) (P. 195)
12. Branchlets not as above ········· 14
   14. Cystocarps broadly urceolate ········· *P. subtilissima* MONT. (P. 197)
   14. Cystocarps not as above ········· 15
15. Cystocarps ovate ········· *P. scopulorum* HARV. (P. 200)
15. Cystocarps globose ········· *P. Savatieri* HARIOT (P. 202)
   13. Fronds forming a mass and extremely expanded ········· *P. tongatensis* HARV. (P. 207)
   13. Fronds not as above ········· 16
16. Fronds forming mats, coarse, stiff, with short articulations ········· *P. ferulacea* SUHR (P. 209)
16. Fronds not as above ········· *P. Yendoi* SEGI (P. 211)
   5. Filaments with thick, rigid, spine-formed adventitious branchlets ········· *P. spinosa* (AG.) J. AG. (P. 214)
   5. Filaments without such branchlets ········· 17
17. Cortical cells tesserately arranged ········· *P. Harlandii* HARV. (P. 216)
17. Cortical cells not as above ········· 18
   18. Fronds decumbent, minute ········· *P. decumbens* SEGI (P. 218)
   18. Fronds erect, large ········· 19
19. Filaments fibrillose, very elongated, straw-colour ········· *P. nipponica* SEGI (P. 221)
19. Filaments not as above ········· 20
   20. Cystocarps elongato-urceolate ········· *P. novae-angliae* TAYLOR (P. 226)
   20. Cystocarps not as above ········· 21
21. Fronds bushy ········· *P. japonica* HARV. (P. 228)
21. Fronds not as above ········· *P. akkeshiensis* SEGI (P. 232)
   7. Branches exogenously arising ········· 22
   7. Branches endogenously arising ········· 23

22. Branchlets adproximato-corymbose ……………………*P. abscissa* HOOK. et HARV. (P.236)
22. Branchlets not as above ……………………*P. urceolata* (DILLW.) GREV. (P.239)
23. Stichidia tufted ……………………*P. Morrowii* HARV. (P.244)
23. Stichidia not as above ……………………*P. senticulosa* HARV. (P.247)
3. Fronds ecorticated …………………… 24
3. Fronds corticated …………………… 25
24. Filaments with 5 siphons …………………… 26
24. Filaments with more than 5 siphons …………………… 27
26. Fronds regular dichotomous and rhizoids connect with each branches ……………………
*P. forcipata* HARV. (P.251)
26. Fronds and rhizoids not as above ……………………*P. Richardsoni* HOOK. (P.253)
27. Filaments elongated, with 8–10 siphons ……………………*P. tapinocarpa* SURING. (P.254)
27. Filaments small, with 12–13 siphons ……………………*P. yonakuniensis* SEGI (P.257)
25. Fronds with 5 siphons ……………………*P. porrecta* SEGI (P.260)
25. Fronds with more than 5 siphons …………………… 28
28. Branchlets fasciculato-penicillate ……………………*P. Brodiaei* (DILLW.) GREV. (P.263)
28. Branchlets not as above …………………… 29
29. Fronds with 8 siphons ……………………*P. fruticulosa* (WULF.) SPRENG. (P.264)
29. Fronds with more than 8 siphons …………………… 30
30. Fronds with 9 siphons and corticated near the base ……………………*P. notoensis* SEGI (P.266)
30. Fronds with 11 siphons and corticated throughout the frond ……………………
*P. crassa* OKAM. (P.269)

## V. DESCRIPTIONS AND NOTES OF THE SPECIES

### Polysiphonia Kampsaxii BOERGESEN

Pl. II, 2, and Text-fig. 2.

Mar. Alg. Iranian Gulf (1939) p. 122, figs. 35–38.

Japanese name: *Take-itogusa* (nov.)

Hab.: Babukutsu, Formosa (Y. NAKAMURA).

Distri.: Bushire, Iranian Gulf.

Fronds caespitose, tufted, slender, elongate, erect, rather robust and thick, ca. 4.5–5 cm. high, assurgent from prostrate creeping filaments; prostrate filaments tangled, 375–420$\mu$ thick, attached by unicellular rhizoids; rhizoids irregularly arising as outgrowths of the corner of the pericentral cells not cut off by cross walls, 300–1170$\mu$ long, 45–60$\mu$ thick, sometimes provided with a discoid hapter at the end; erect filaments arising exogenously from the prostrate filaments, 390$\mu$ thick near the base, almost equally thick or slightly attenuated upwards, with main axes indistinct, sparsely and distantly ramified, dichotomously branched in subalternate or irregular manner with rather narrow

axils, upwards assuming collapsed and complanate form; branches arising exogenously at intervals 15-29 segments apart, rather acute angles with the main filament; branchlets nude at the base, upwards sometimes branched in subfastigiato-corymbose manner; ultimate branchlets virgate, slightly narrow at the base, 150$\mu$ thick at the middle, rather acute at the tip; adventitious branchlets often developed; trichoblasts sometimes scantily arising near the apex, degenerated, persistent, sometimes well developed here and there, one on each segment, arising in a left hand spiral with ¼ divergence, robust, elon-

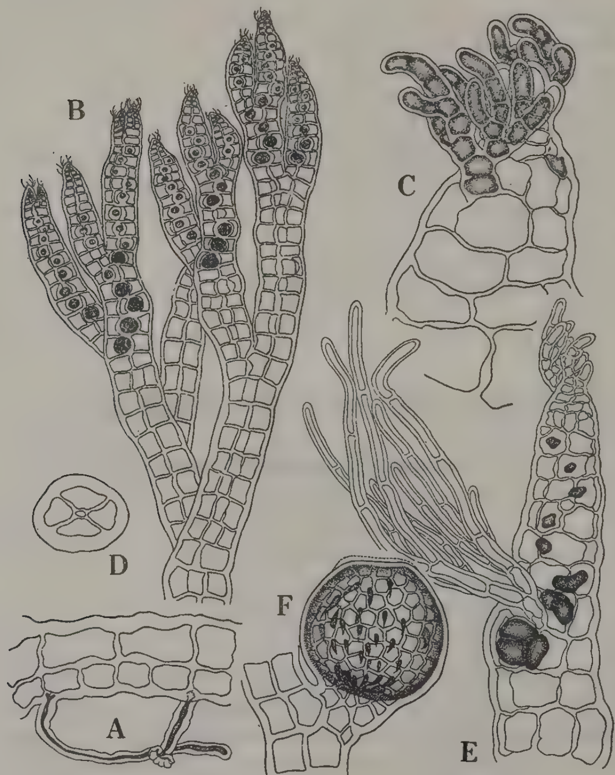



Fig. 2: *Polysiphonia Kampsaxii* BOERGESEN. A. Rhizoids. ×35; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond. ×35; E. Upper part of the branchlet with tetraspores. ×115; F. Cystocarp. ×60.

gate, 1–2 forked, 300$\mu$ long, leaving conspicuous scar-cells; branches replacing trichoblasts; articulations opake, short, ecorticated, thick walled, 0.5 times as long as diam. at the lower, 0.7 times at the middle, as long as diam. at the upper part of main filaments; siphons 4 in number; tetrasporangia numerously and spirally seriate on the upper parts of branchlets, globose, rather small, about 52–75$\mu$ diam., tripartitely divided; cystocarps a few scattered on the ultimate branchlets, globose or broadly urceolate, 435$\times$390$\mu$, supported by rather broad base, with wide ostiole at the tip. Colour dark brownish black. Specimens not adhering to paper in drying.

The present species was found forming a dark brownish tuft. In the tetrasporic filament the branchlets are often ramified in subfastigiato-corymbose manner upwards, but in the cystocarpic one they are not branched in such manner. The rhizoids are placed one on each segment typically, but often a few aggregated irregularly on it. In some cases the rhizoids arising at the lower part of erect filament are very slender and extremely elongated. The peripheral walls of the stem are very thick and about 75$\mu$ in thickness.

Materials at hand agree well with detailed descriptions and figures of *P. Kampsaxii* BOERGESEN given by the original author (l. c.), except only for a few following points. In the Formosan specimens the fronds are 4.5–5 cm. in height and the articulations are 0.5–1 times as long as diam., while BOERGESEN measured them in his specimens as about 10 cm. and 2–3 times respectively. The trichoblasts are not so much developed as those of the Iranian species. But here and there the robust trichoblasts are arising vigorously as shown in Figure 2, E. The tetrasporangia are much smaller in diameter than those of foreign species. The cystocarps are supported by rather broad base.

On the other hand this species seems to be closely related to *P. breviarticulata* (AG.) ZANARD. f. *mexicana* figured in KUETZING's Tab. Phyc. vol. 13 (1863) pl. 64. According to BOERGESEN, however, in the latter species the branches issue in the corner of the trichoblasts, connecting with them, (Mar. Alg. Canary Isl. III, 1930, p. 92, fig. 37, a), whereas in the former one this is not the case. On this main point these two allied species are different from each other most distinctly.

## Polysiphonia codiicola ZANARDINI

Pl. III, 1, and Text-fig. 3.

KUETZING, Tab. Phyc. vol. 14 (1864) p. 19, pl. 52, figs. a–c; DE TONI, Syll. Alg. vol. 4 (1903) p. 959.

Syn. (?) *P. Kotschyana* GRUNOW, Alg. Novara (1867) p, 89, pl. 11, fig. 2; DE TONI, Syll. Alg. vol. 4 (1903) p. 888.

Japanese name: *Bara-itogusa* (nov.).

Hab.: Rishiri Isl., (T. YOSHIDA) and Todoshima, Rebun Isl. (J. TOKIDA), Hokkaidō.

Distri.: Dalmatic, Adriatic Sea and Cyprus Isl., Mediterranean Sea.

Fronds caespitose, forming dense tufts, fine, flaccid, rather small, 2.6–3.4 cm. high, arising from prostrate creeping filaments; prostrate filaments about 240$\mu$ thick, tangled, attached by unicellular rhizoids; rhizoids scantily and irregularly arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, one or more per segment, often aggregated, 450–900$\mu$ long, 30–60$\mu$ thick, with a discoid hapter at the end; erect filaments arising exogenously from the prostrate filaments, about 270–300$\mu$ thick near the base, sometimes prominent at the nodes, gradually attenuated upwards, with main axes distinct, branched in alternate or rather irregular manner, with acute angles; branches arising exogenously at intervals mostly 5–7 segments apart, virgate, gradually shorter above; branchlets subalternately arising at irregular intervals, nude below, above branched in paniculate and penicilliform; ultimate branchlets subulate, 45–60$\mu$ thick near the middle, obtuse and obsolete at the apices; trichoblasts numerously developed near the apex, one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, 1–2 forked, 225–375$\mu$ long, rather persistent, often leaving inconspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, almost equal to diam. at the upper and lower, about 2 times as long as diam. at the middle part of branches; siphons 4 in number; tetrasporangia 4–10 spirally seriate at the upper part of branchlets, continuous, prominent, globose, relatively large, about 60–75$\mu$ diam., tripartitely divided; cystocarps numerously scattered on the upper part of branchlets, globose, about 255–300$\times$240–285$\mu$, pedicellate (1–2 celled), with a wide ostiole at the tip. Colour purplish rose. Specimens imperfectly adhering to paper in drying.

This species was found forming a dense tuft, associated with small *Corallina* sp. It is a very fine and elegant species in the genus. The paniculate branchlet is one of the most distinct characteristic of this species. In

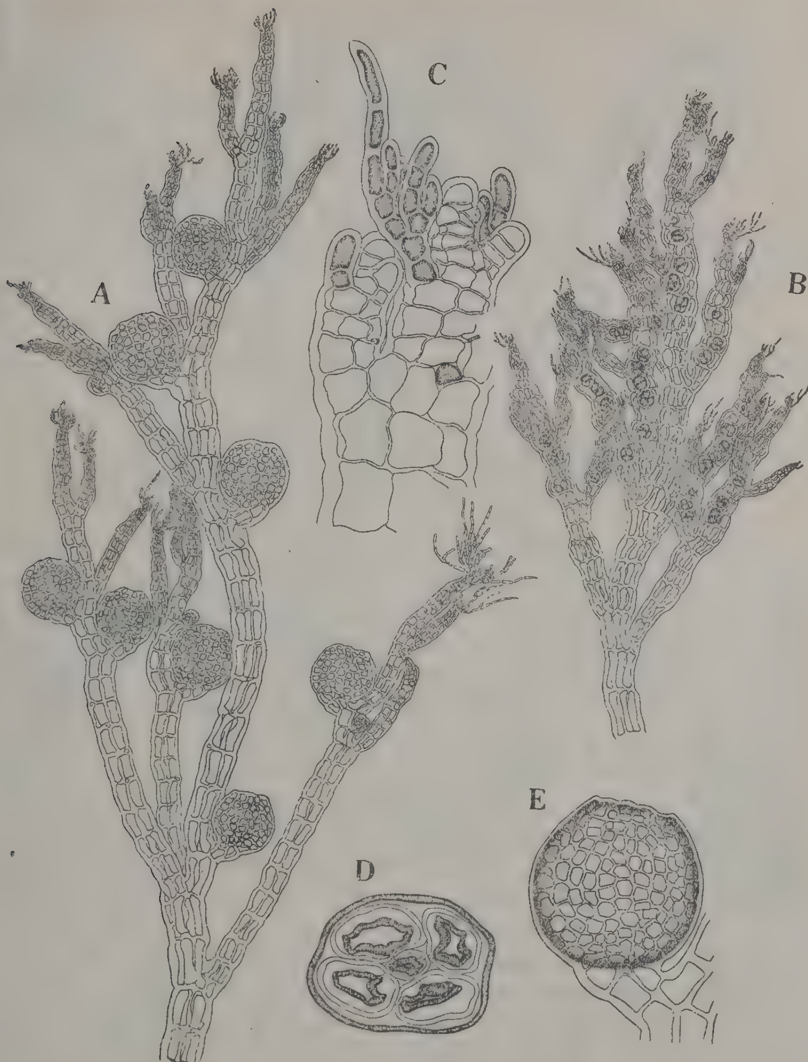



Fig. 3. *Polysiphonia codiicola* ZANARDINI. A. Upper part of the cystocarpic branch. ×35; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond showing pericentral cells with transverse plasma-connections between them and central axial cell. ×115; E. Cystocarp. ×115.

the transverse section of the basal part of the frond, the plasma-connections between central axes and pericentral cells can be seen clearly as shown in Figure 3, D.

Especially in the ramification, the present specimen seems to coincide with the description and figures of *P. codiicola* ZANARDINI which was described rather briefly and known only on tetrasporic frond in KUETZING's Tab. Phyc. (1. c.). In the material at hand the cystocarps are apparently globose and supported by rather long, 1–2 celled stalks, although GRUNOW has stated as ovate in *P. Kotschyana* GRUNOW which was reported as a synonym of this species by DE TONI.

In the writer's opinion *P. codiicola* ZANARDINI should not be referred to *Herposiphonia* at all, though DE TONI expressed a doubt on it (1. c.).

## Polysiphonia obsoleta SEGI spec. nov.

Pl. III, 2, and Text-figs. 4–5.

Frondes mattas densas formantes, saxicolae, gracillimae, fere rigidae, setaceae, assurgentes ex filamentis prostratis repentibus; filamentis prostratis paulum torulosis, 165–195$\mu$ crassis, per rhizoidea unicellularia affixis; rhizoideis ex angulo aut centro cellularum pericentralium excrescentibus, per muros transversos non abscissis, uno vel pluribus per segmentum robustis vel tenuibus, 150–750$\mu$ longis, 45–60$\mu$ crassis, interdum discum terminalem relativiter magnum ferentibus; filamentis erectis ex filamentis prostratis exogene ortis, 210$\mu$ crassis ad basin, sursum sensim attenuatis, cum axibus principibus distinctis, paulum prominentibus in nodis, alternato-subdichotomis ramosis; ramis exogene in intervallis 6–9 segmentis separatis, fere in angulis acutis cum axibus principibus orientibus, elongatis, flexuosis, apice obsoletis; ramulis ultimis subulatis, paulum attenuatis ad basin, 60–75$\mu$ crassis in parte media; trichoblastis numerosis, uno per segmentum, spiram laevam $\frac{1}{4}$ divergentem facientibus, delicatis, elongatis, 1–2 frucatis, 375–450$\mu$ longis, frequenter cicatricellulas persistentes relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis pellucidis, ecorticatis, ca. 1.5 plo diam. longioribus in parte basali, ca. 2 plo in parte media, ca. 0.6 plo in parte superiore ramorum; siphoniis 4; tetrasporangiis 16–21 spiraliter in seriebus in partibus superioribus ramulorum, longe longitudinaliter dispositis, continuis vel interdum interruptis, prominentibus, globosis, 40–60$\mu$ crassis, tripartite divisis; cystocarpiis in partibus superioribus ramulorum sparsis, angusti-ovatis, magnitudinaliter inaequalibus, 14–210 $\times$ 220–270$\mu$, pedicellatis unicellularibus, apice ostiolo angusto ornatis; antheridiis numerosis dispositis in apicibus ramulorum, ut unus ramus tricho-

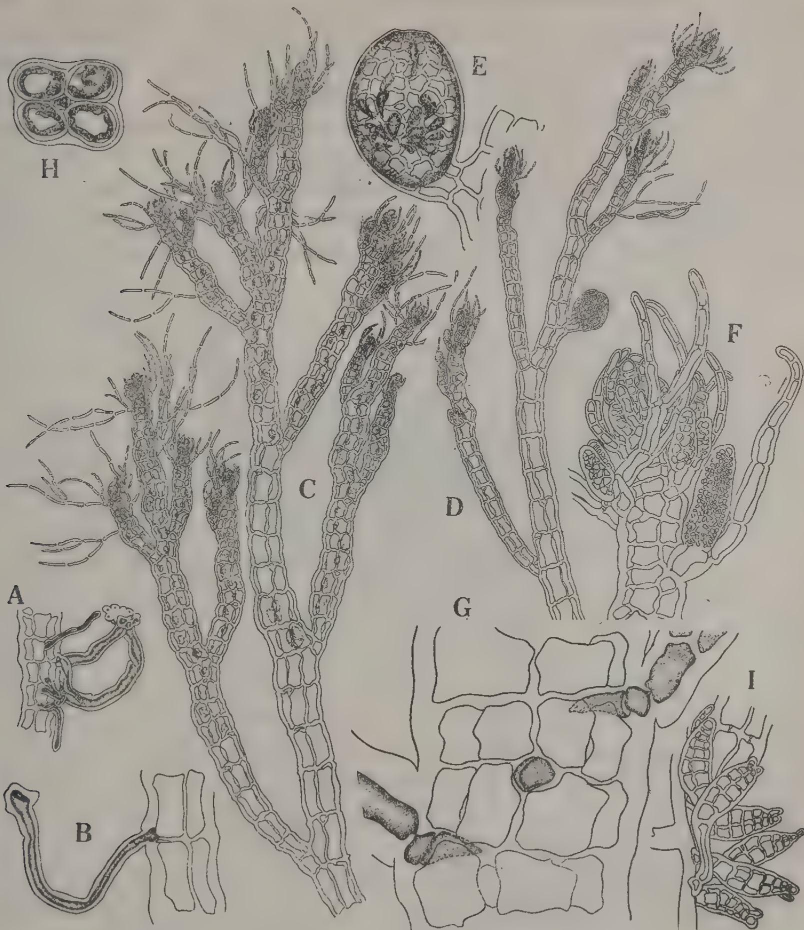



Fig. 4. *Polysiphonia obsoleta* SEGI. A-B. Rhizoids. ×60; C. Upper part of the tetrasporic branch. ×60; D. Upper part of the cystocarpic branch. ×60; E. Cystocarp. ×115; F. Antheridia. ×200; G. Basal part of the trichoblasts bearing two basal cells. ×400; H. Transverse section of the basal part of the frond. ×60; I. Young plants. ×230.

blasti ortis, cylindraceis, 20–30×80–97$\mu$, apicibus brevibus unicellularibus sterilibus. Color fusco-purpureus. Specimina exsiccatione chartae imperfecte vel non adhaerent.

Japanese name: *Hoso-itogusa.*

Hab.: Shiokubi, Hokkaidō (Y. SAKAI).

Fronds forming dense mats, saxicolous, very fine, rather rigid, setaceous, assurgent from prostrate creeping filaments; prostrate filaments slightly torulose, 165–195$\mu$ thick, attached by unicellular rhizoids; rhizoids arising as outgrowths of the corner or centre of the pericentral cells, not cut off by cross walls, one or more per segment, robust or slender, 150–750$\mu$ long, 45–60$\mu$ thick, sometimes provided with a relatively large discoid hapter at the end; erect filaments arising exogenously from the prostrate filaments, 210$\mu$ thick near the base, gradually attenuated upwards, with principal axes distinct, slightly prominent at the nodes, alternately branched in subdichotomous manner; branches

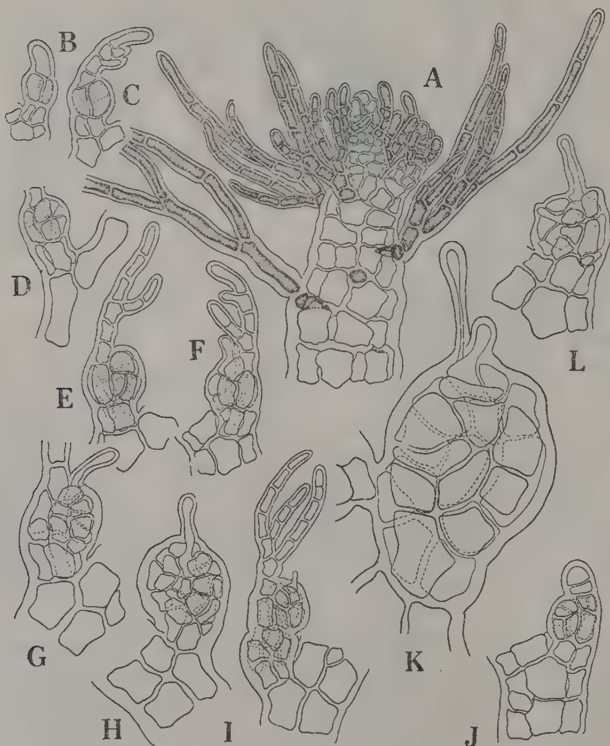



Fig. 5. *Polysiphonia obsoleta* SEGI. A. Tip of the branch. ×200; B–H. Development of procarp. ×ca. 350; I. Two procarps arising seriately. ×ca. 350; J. Procarp arising on branchlet. ×ca. 350; K. Procarp bearing two trichogynes (?). ×ca. 650; L. Procarp bearing two trichogynes (?). ×ca. 350.

arising exogenously at intervals 6–9 segments apart, mostly in acute angles with the principal axes, elongate, flexuose, obsolete at the apex; ultimate branchlets subulate, slightly narrow at the base, 60–75$\mu$ thick in the middle; trichoblasts numerously developed, one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, delicate, elongate, 1–2 forked, 375–450$\mu$ long, often leaving persistent scar-cells; branches not associated with trichoblast in origin; articulations pellucid, ecorticated, about 1.5 times as long as diam. at the basal, about 2 times at the middle, about 0.6 times at the upper part of branches; siphons 4 in number; tetrasporangia 16–21 spirally seriate on the upper parts of branchlets, arranged in a long longitudinal line, continuous or sometimes interrupted, prominent, globose, 40–60$\mu$ diam., tripartitely divided; cystocarps scattered on the upper parts of branches, narrow ovate, variable in size, 140–210×220–270$\mu$, one-celled pedicellate, with a narrow ostiole at the tip; antheridia numerously produced on the apices of branchlets, arising as a primary branch of trichoblast, cylindrical, 20–30×80–97$\mu$, with a short one-celled sterile tip. Colour brownish purple. Specimens imperfectly or not adhering to paper in drying.

The new species was found forming a dense mat, associated with small *Corallina*. The trichoblasts are numerously and vigorously developed on the ultimate branchlets. The scar-cells can be seen clearly one on each node between the pericentral cells and they may sometimes give rise to cicatrigenous branches, sometimes to trichoblasts. The tips of branches are apparently obsolete. This species is characterized by possessing the rather narrow ovate cystocarps. The development of procarp can be followed clearly as figured (Fig. 5, B–H). Of special interest is the fact that sometimes two scar-cells, trichogynes (?), procarps and antheridia occur in the point of insertion of the trichoblasts, on the tip of carpogonal branch, on the same trichoblast, and on one trichoblast respectively. In such case the procarps or antheridia arise on each trichoblast seriately. Commonly the procarp arises on the trichoblast as noted above, but rarely it grows on the branchlet besides the trichoblast (Fig. 5, J.).

In the material at hand the younger plant developing upon the mature one can be seen here and there (Fig. 4, I). In the sporelings, the lowermost cell of the plant is extremely elongated and originates slender first rhizoid. Afterwards this rhizoid is irregularly bulged and divided into two parts near the apex. The lowermost part becomes discoid hapter, by which it is fastened to the host plant. This young plant seems to be 7–10 days old, according to Inoh (as *P. japonica*, Kaisō no hassei, 1947, p. 199, fig. 194).

This species is most closely related to *P. subtilissima* Montagne in habit, but differs from it in the fact that the branchlets are more finely and numerously ramified, the trichoblasts are more abundantly developed than those of

MONTAGNE's species, the cystocarps are characteristic narrow ovate and the tetraspores occur on the whole parts of penultimate or ultimate branchlets.

### Polysiphonia Tokidae SEGI spec. nov.

Pl. III, 3–4, and Text-fig. 6.

Syn. *P. macrocarpa* (non HARVEY) YENDO, Notes on Alg. New to Japan, VIII (Bot. Mag. Tokyō, vol. 32, 1918) p. 73.

Syn. *P. sertularioides* (non J. AGARDH) OKAMURA, Nippon Kaisō Shi (1936) p. 826.

Frondes caespitosae, eximie tenues, flaccidissimae, capillares, 1.6–4.2 cm. altae, ex disco basali assurgentes; filamentis erectis 480–570$\mu$ crassis prope basim cum nullis axibus principibus, infra acutangulariter dichotomis sparsis ramosis, supra repetitis alternatis et secundis subpenicillatis ramosis, adventiciis ramulis fere numerosis ornatis, per rhizoidea unicellularia affixis; rhizoideis paulum ex centro cellularum pericentralium excrescentibus, per muros transversos abscissis, uno per segmentum, ca. 750$\mu$ longis, ca. 30$\mu$ crassis, interdum discum terminalem ferentibus; ramis in intervallis irregularibus orientibus, communiter 1–4–6–8 segmentis separatis, elongatis, leviter flexuosis, infra ramulis tenuibus erectis alternatis rectangulariter ornatis, supra ramulis tenuibus brevibus secundatis acutangulariter ornatis; ramulis ultimis virgatis, basi fere non attenuatis, 45$\mu$ crassis, apice fere acutis; trichoblastis modeste prope apicem emittentibus, uno per segmentum, spiram laevam ¼ divergentem facientibus, 1–3 furcatis, longissime ca. 150$\mu$ longis, deciduis, cicatricellulas inconspicuas relinquentibus; ramis trichoblastorum vicem; articulis pellucidis, ecorticatis, paulum brevioribus diam. in parte basali, ca. 2.1 plo in parte media, paulum longioribus in parte superiore ramorum erectorum; siphoniis 4; tetrasporangiis 9–14 spiraliter in partibus superioribus ramulorum seriatis, continuis, verrucosis, prominentibus, globosis, ca. 60–80$\mu$ diam., tripartite divisis; procarpiis sparsis, ex segmento secundo trichoblasti orientibus, ca. 40$\mu$ diam. Color purpureo-cinereus (?). Specimina exsiccatione chartae adhaerent.

Japanese name: *Usu-itogusa.*

Hab.: Ubaranai, Hokkaidō (J. TOKIDA).

Fronds caespitose, extremely fine, very flaccid, capillary, 1.6–4.2 cm. high, arising from a discoid base, erect filaments 480–570$\mu$ thick near the base, with no principal axes, below dichotomously and sparsely branched with acute angles, above repeatedly and alternately or secundly branched in sub-penicillate form, provided with rather numerous adventitious branchlets, attached by unicellular rhizoids; rhizoids scantily arising as outgrowths of the centre of

the pericentral cells, cut off by cross walls, one on each segment, about 750$\mu$ long, about 30$\mu$ thick, sometimes provided with a discoid hapter at the end; branches arising at irregular intervals, commonly 1–4–6–8 segments apart,

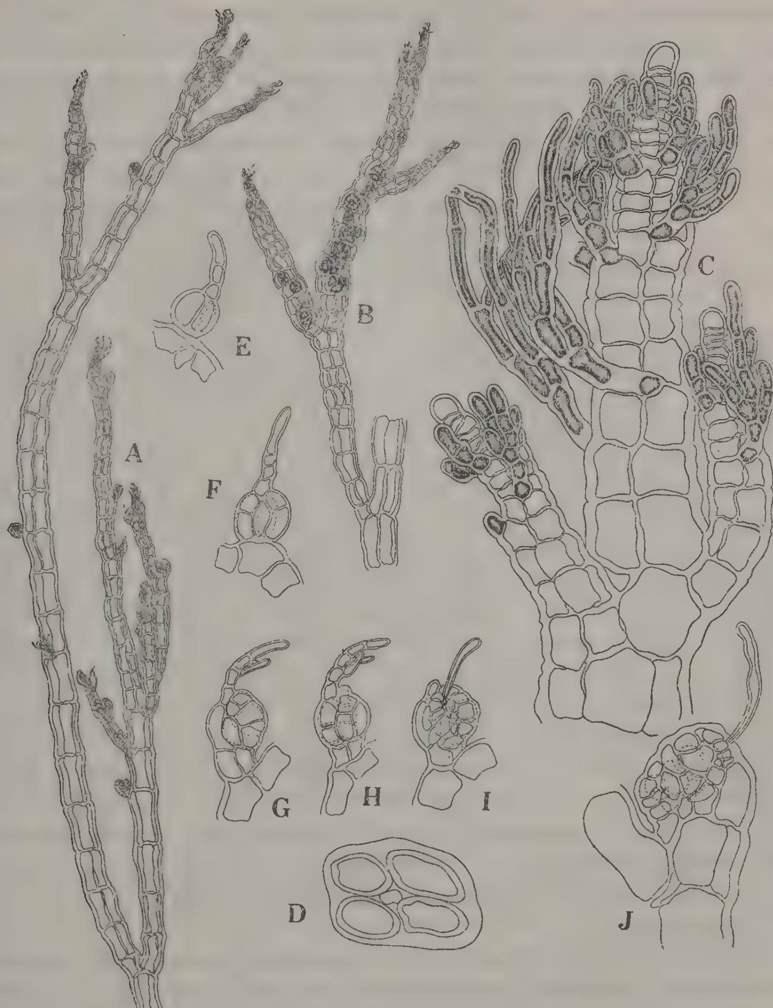



Fig. 6. *Polysiphonia Tokidae* SEGI. A. Upper part of the cystocarpic branch. ×35; B. Branchlet with tetraspores. ×35; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond. ×60; E–J. Development of Procarps. ×350.

elongate, slightly flexuose, below rectangularly beset with fine, erect branchlets in alternate manner, above acutely beset with fine, shorter branchlets in secund manner; ultimate branchlets virgate, almost not narrowed at the base, $45\mu$ thick, rather acute at the tip; trichoblasts moderately developed near the apex, one per segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, 1–3 forked, about $150\mu$ long in the longest, deciduous, leaving inconspicuous scar-cells; branches replacing trichoblasts; articulations pellucid, ecorticated, slightly shorter than diam. at the basal, about 2.1 times at the middle, slightly longer than diam. at the upper part of erect branches; siphons 4 in number; tetrasporangia 9-14 spirally seriate on the upper parts of branchlets, continuous, verrucose, prominent, globose, about $60$–$80\mu$ diam., tripartitely divided; procarps scattered, arising from second segment of trichoblast, about $40\mu$ diam. Colour dull purplish grey (?). Specimens adhering to paper in drying.

The new species is the most delicate and flaccid species in this genus. The present material which has been preserved in formalin solution is dull and pale purplish grey in colour and the frond is densely covered with diatoms. The frond is rather sparsely branched. The development of procarp can be followed clearly as figured, although the cystocarp could not be observed.

Judging from the descriptions and figures of *P. sertularioides* (GRATELOUP) J. AGARDH given by the original author (Spec. Alg. vol. 2, 1863, p. 969), ARDISSONE (Phyc. Mediter. vol. 1, 1883, p. 395), HAUCK (Meeresalg. 1885, p. 220, as $\beta$, tenerrima), FALKENBERG (Rhodomelac. 1901, p. 122, pl. 1, figs. 1–16) and the photograph of it (as "f. *epiphytica*", Herb. Univ. Calif. No. 495036, Mittel-Dalmatien and Insel Bua, Nordkueste, Leg. and Det. SCHIFFNER), the new species shows a strong resemblance to *P. sertularioides* in external appearance. On the other hand, especially in the shape of tetrasporic branchlets this species shows much likeness to *P. Jacobi* DE NOT. (KUETZING's Tab. Phyc. vol. 13, 1863, pl. 89), which has been referred to *P. sertularioides* by DE TONI (Syll. Alg. vol. 4, 1903, p. 870). In *P. sertularioides*, however, KNY (Axillarkno. Florid. 1873, p. 105, pl. 2, figs. 1–4), FALKENBERG (1. c.) reported that the branches arise in the axils of trichoblasts, being in connection with trichoblasts at the base. In the Japanese species, on the contrary, such characteristic can not surely be seen. The branches occur independently, having no relation to the trichoblasts in origin.

OKAMURA (1. c.) and YENDO (1. c.) reported the presence of *P. sertularioides* in Japan. The writer considers that so-called "*P. sertularioides*" in foreign countries is not distributed in our boundary. The photograph of *P. macrocarpa* HARVEY determinated by YENDO (Herb. Univ. Calif. No. 200410, Shiriya, Mutsu Prov., Coll. ROSENBAUN) accords rather well with this species in general.

## **Polysiphonia pulvinata** J. AGARDH (?)

Pl. III, 5, and Text-fig. 7.

Alg. Med. (1842) p. 124; Id., Spec. Alg. vol. 2 (1863) p. 957; KUETZING, Spec. Alg. (1849) p. 806; Id., Tab. Phyc. vol. 13 (1863) pl. 36, figs. a–e; ARDISSONE, Phyc. Mediter. vol. I (1883) p. 375; HAUCK, Meeresalg. (1885) p. 219; DE TONI, Syll. Alg. vol. 4 (1903) p. 895, vol. 6 (1924) p. 396.

Syn *Conferva pulvinata* ROTH, Catal. bot. I (1797) p. 187, t. 3, fig. 4 (nec 5), l. c. II (1800) p. 214.

Japanese name: *Hina-itogusa* (nov).

Hab.: Garanbi, Formosa (T. TANAKA).

Distri.: Atlantic Ocean; Mediterranean Sea, Sardinia Isl., Ligurian Sea, Adriatic Sea.

Fronds forming mats, sometimes considerable extent, fine setaceous, rather rigid, small, 1.3-2 cm. high, assurgent from prostrate creeping filaments; prostrate filaments intricated, often recurved, prominent at the nodes, about 180-300$\mu$ thick, attached by unicellular rhizoids; rhizoids arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, one or more numerous per segment, 150–375$\mu$ long, 30–60$\mu$ thick, sometimes provided with a discoid hapter at the end; erect filaments arising exogenously from the prostrate filaments with right angles, prominent at the nodes, 195–225$\mu$ thick, near the middle, slightly and gradually attenuated on both sides, with main axes distinct, sparsely branched in subalternate manner with acute angles; branches arising exogenously at irregular intervals, mostly 3-6-9 segments apart, nude downwards, upwards densely branched in subfastigiato-corymbose manner, simple or furcate at the apex; ultimate branchlets subulate, often almost rectangularly issued, about 60$\mu$ thick, rather acute at the tip; trichoblasts moderately developed near the apex of branches, usually one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, delicate, simple or once forked, about 225$\mu$ long in the longest, leaving conspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, almost as long as diam. at the basal, about 2 times at the middle and upper part of branches; siphons 4 in number; tetrasporangia 7-12 spirally formed on the torulose branchlets, continuous or interrupted, extremely prominent verrucose, globose, about 60$\mu$ diam., tripartitely divided. Colour brownish black. Specimens not or imperfectly adhering to paper in drying.

The present species has densely matted habit. The basal part of the frond sends out many rhizoids by means of which it is fastened to the subst-

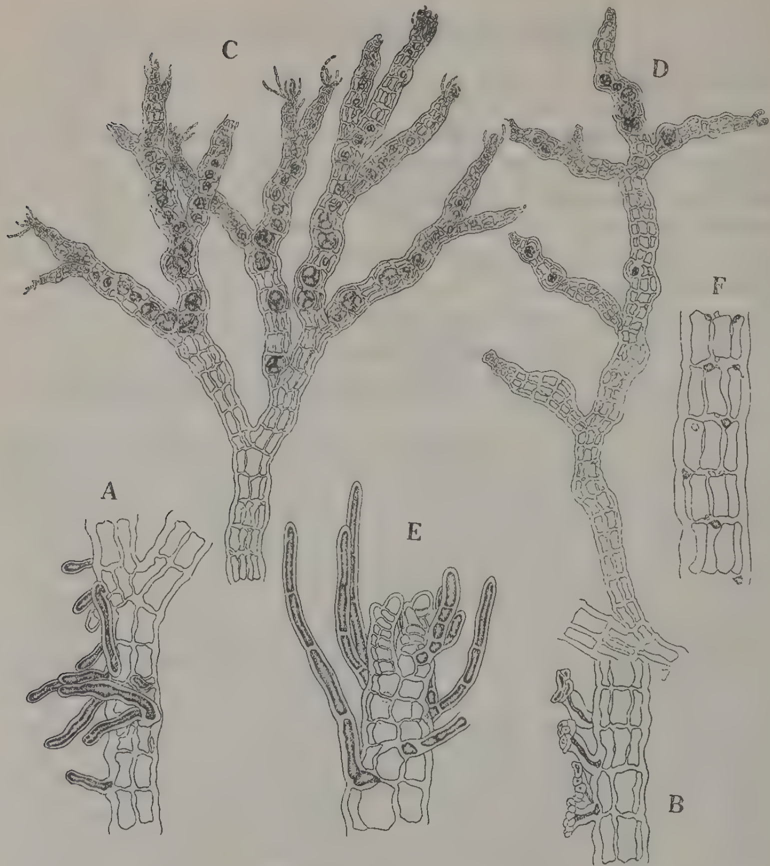



Fig. 7. *Polysiphonia pulvinata* J. AGARDH (?) A-B. Rhizoids. ×60; C. Upper part of the tetrasporic branch. ×60; D. Branchlet with tetraspores. ×60; E. Tip of the branch. × 350; F. Part of the frond bearing two scar-cells on the same node oppositely. ×120.

ratum. The rhizoids are sometimes slender and very elongated and often they occur on the same position of the pericentral cell aggregately. The branches arising from the lower part of the frond are more or less determinate and show limited growth. But the upper branches are well developed and densely branched in corymbose manner near the apex. Of special interest is the fact that in the materials at hand two scar-cells are oppositely present on each

node of the erect filaments as shown in Figure 7, F.

This species seems to answer rather well to the original description and figures of *P. pulvinata* given by KUETZING, ROTH (as *Conferva pulvinata*).

As compared with foreign specimens of this species (Herb. KUETZING, Terraeina), the Garanbi ones rather agree with them in general, except only for the shape of branchlets. In the Formosan specimens the branchlets are ramified in subfastigiato-corymbose manner upwards, being different from those of foreign ones.

To his regret the writer has not been able to observe any sexual reproductive organ in the present materials, so for the present provisionally identified it with *P. pulvinata*.

## Polysiphonia subtilissima MONTAGNE

Pl. III, 6, and Text-fig. 8.

"Centurie II, n. 6 (in Ann. Sc. Nat. Avr. 1840, Syll.) p. 442"; KUETZING, Spec. Alg. (1849) p. 804; Id., Tab. Phyc. vol. 13 (1863) pl. 28, figs. a–e; HARVEY, Ner. Bor. Amer. (1853) p. 34; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 962; FARLOW, Mar. Alg. New Eng. (1881) p. 178; Phyc. Bor. Amer. Fas. 1 (1892) No. 45; DE TONI, Syll. Alg. vol. 4 (1903) p. 874; l. c. vol. 6 (1924) p. 393; PILGER, Meeresalg. Kamerum (in ENGLER's Jahrb. vol. 46, 1911) p. 304; TAYLOR, Mar. Alg. Northeast. coast of North Amer. (1937) p. 365; TSENG, Mar. Alg. Hong Kong, VI. Polysiphonia (Papers Michigan Acad. Sci. Arts and Lett. vol. 29, 1944) p. 70, pl. 1.

Japanese name: *Kinukomachi* (nov.).

Hab.: Samani, Hokkaidō (H. MIKAMI).

Distri.: Atlantic coast of France and America; Hong Kong.

Fronds forming mats, fine, flaccid, setaceous, non-gelatinous, 1.5–2.4 cm. high, arising from creeping filaments; creeping filaments tangled 150–180$\mu$ thick, slightly prominent at the nodes, composed of shorter segments (about 0.5 times as long as diam.); erect filaments perpendicularly arising from the creeping filaments, about 150–240$\mu$ thick near the base, gradually attenuated upwards, slightly prominent at the nodes, often dichotomously branched in alternate or unilateral manner with acute angles, attached by numerous unicellular rhizoids; rhizoids issuing near the basal part of erect filaments and from creeping ones, arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, seldom more than one per segment, sometimes short and thick, 240-345$\mu$ long, 45–75$\mu$ thick, sometimes very elongate and slender, about 1200$\mu$ long, 30$\mu$ thick, often provided with a small dilated hapter at the

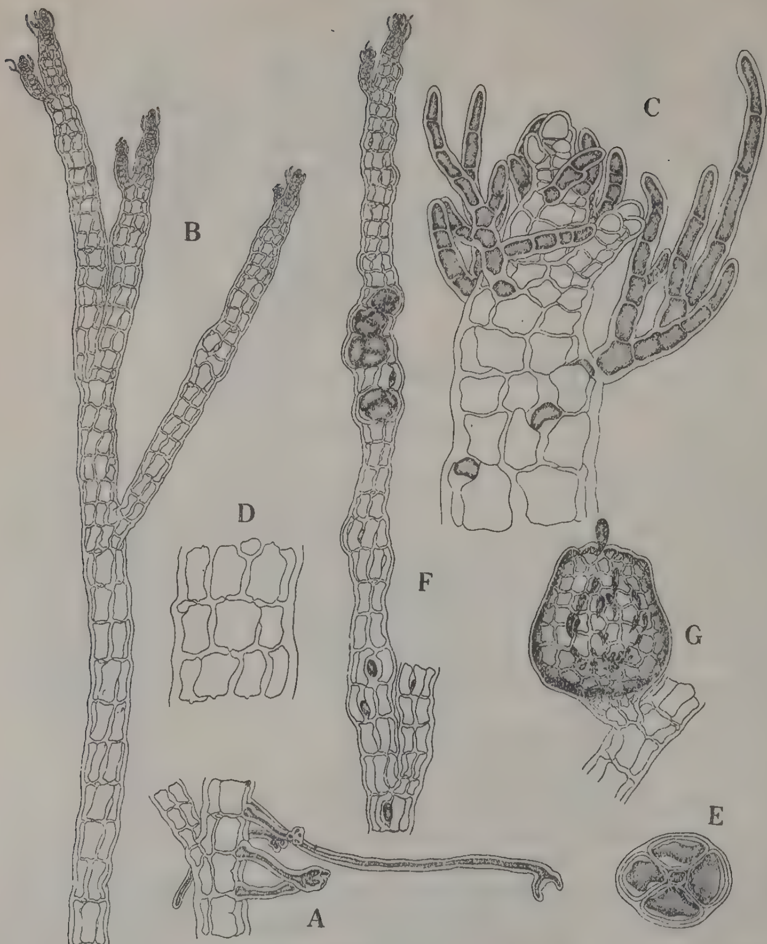



Fig. 8. *Polysiphonia subtilissima* MONTAGNE. A. Rhizoids. ×35; B. Upper part of the branch. ×60; C. Tip of the branch. ×350; D. Part of the frond showing pericentral cells with longitudinal plasma-connections. ×240; E. Transverse section of the basal part of the frond. ×115; F. Branchlet with tetraspores. ×60; G. Cystocarp. ×60.

end; branches arising exogenously at intervals 5–6–(12) segments apart, below with patent axils, gradually narrow axils above, slender, elongate, flexuose or erect, rather nude below, above sometimes branched in wandlike to clustered;

branchlets virgate, straight, often patent, slightly constricted at the base, simple or bifid, obsolete at the apex; adventitious branchlets not numerous; trichoblasts moderately developed near the apex of branches, one per segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, 1–3 forked, about 150$\mu$ long, rather persistent, leaving conspicuous scar-cells; lateral branches replacing trichoblasts; articulations pellucid, ecorticated, about 0.8 times as long as diam. near the basal, about 1.6 times at the middle, as long as diam. at the upper part of erect filaments; siphons 4 in number; tetrasporangia numerously and spirally seriate on the middle parts of penultimate branchlets, moniliformed, sometimes extremely prominent and large, continuous or interrupted, globose, about 75$\mu$ diam., tripartitely or cruciately divided; cystocarps scattered on the middle parts of branchlets, broadly urceolate, 345-420×405-450$\mu$, shortly pedicellate (1-celled), with a broad cleft at the tip. Colour blackish purple. Specimens adhering to paper in drying.

The present species was found forming a dense mat, associated with small *Corallina* sp. It is characterized by possessing such branchlets upwards as wandlike to clustered. The ramification is considerably irregular, sometimes rather dichotomous, sometimes alternate or secund. In the present materials the longitudinal plasma-connections between neighbouring pericentral cells can be seen clearly as shown in Figure 8, D. The ripe tetraspores are mainly formed on the middle part of the branchlets in longitudinal series, as noted by DE TONI, TAYLOR and TSENG (l. c.). The cystocarps are generally broadly urceolate with a wide mouth, but sometimes ovate with a narrow one (300–345×345–390$\mu$).

In some cases this species is very similar to *P. Yendoi* SEGI in general appearance. KUETZING's figures of this species (Tab. Phyc. l. c.) also seem to show some resemblance to *P. Yendoi*, on the other hand. The present species has many characters in common with *P. Yendoi*, but differs from it in the fact that the frond is shorter and setaceous (not gelatinous), the branchlets is wandlike to clustered (not corymbose) and composed of longer segments than those of *P. Yendoi*, and the cystocarp is characteristic broad urceolate.

Being compared with American specimens (Phyc. Bor. Amer. Fas. 1, 1892, No. 45), the abundant materials from Samani agree quite well with them on the whole.

## Polysiphonia scopulorum HARVEY

Pl. III, 7, and Text-fig. 9.

"Mar. Bot. of West Austr. n. 88 (in Trans. Irish Ac. vol. 22) p. 540; Id., Austr. Alg. n. 186"; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 940; KUETZING, Tab. Phyc. vol. 14 (1864) p. 12, pl. 37, figs. a–c; DE TONI, Syll. Alg. vol. 4 (1903) p. 1065.

Syn. *P. ferulacea* (non SUHR) YENDO, Notes on Alg. New to Japan VIII (Bot. Mag. Tōkyō vol. 32, 1918) p. 75.

Japanese name: *Owari-itogusa* (nov.).

Hab.: Shinmaiko, Owari Prov.; Enoshima, Sagami Prov. (K. YENDO); Shimoda, Izu Prov. (K. YENDO); Nakiri, Shima Prov.; Tomioka, Amakusa Isl., Higo Prov. (T. TANAKA); Kujiranami (M. NAKAMURA) and Nou (K. YENDO), Echigo Prov.; Batan (T. AOKI).

Distri.: New Holland.

Fronds caespitose, saxicolous, fine, flaccid, rather small, 2.3–4.5 cm. high, assurgent from a decumbent base; erect filaments 300–360$\mu$ thick near the base, prominent at the nodes, gradually attenuated upwards, slightly compressed below, cylindrical above, with main axes distinct, subdichotomously and distantly ramified in alternate manner with wide angles, attached by uni- or bicellular rhizoids; rhizoids arising as outgrowths of the corner or centre of the pericentral cells, cut off by cross walls, sometimes more than one per segment, long, slender, 525–900$\mu$ long, 30–75$\mu$ thick, sometimes provided with a discoid hapter at the end; branches arising exogenously at intervals 6–7 segment apart, 165–195$\mu$ thick near the base, the lowest arising almost with right angles at the base, the rest patent, slender, flexuose, nude below, above densely branched, assuming fasciculate form; ultimate branchlets subulate, recurved, slightly narrow at the base, about 75$\mu$ thick; trichoblasts scantily arising near the tip, one per segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, degenerate, simple or once forked, about 75$\mu$ long, rather persistent, leaving scar-cells; branches not arising in connection with them; articulation pellucid, ecorticated, as long as diam. at the basal and middle, about 0.4 times at the upper part of erect branches; siphons 4 in number; tetrasporangia sometimes irregularly and discontinuously scattered in the torulose branchlets, sometimes spirally seriate in a longitudinal line near the tip, slightly prominent or extremely incrassate, globose, about 90$\mu$ diam., tripartitely divided; cystocarps a few distantly scattered on the branchlets and branches, not aggregated, ovate, very shortly pedicellate, about $240 \times 300\mu$, with

narrow ostiole at the tip. Colour brown. Specimens adhering to paper in drying.

The present species is rather common on somewhat mud-swept rocks in

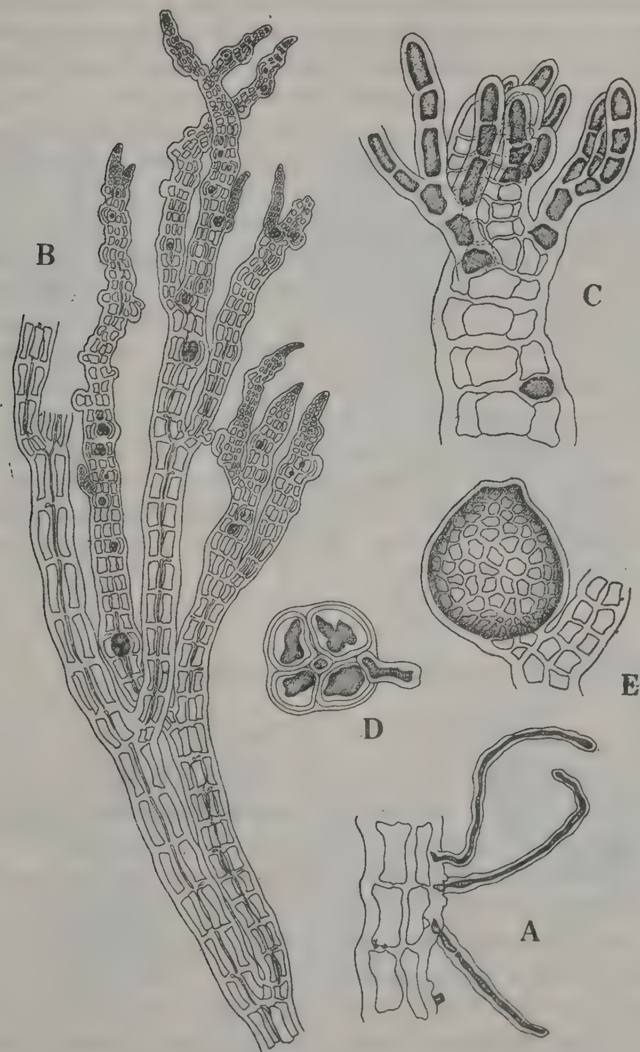



Fig. 9. *Polysiphonia scopulorum* HARVEY. A. Rhizoids. ×35; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond. ×115; E. Cystocarp. ×60.

the low littoral zone along the coast of Shinmaiko. It is distributed in the warmer parts of Japan. In the materials at hand the fronds are densely covered with diatoms and the branchlets are extremely swollen in various parts forming tetraspores (Fig. 9, B). The branchlets are virgate in form and often ramified in subfastigiato-corymbose manner at the upper part of them. In the materials from Shinmaiko a few tetrasporangia and cystocarps are distantly scattered on the branchlets, being not seriately or aggregately arranged. But in the abundant specimens from Amakusa Isl. the tetraspores are arranged in a long longitudinal series on the branchlets, having a tendency to become discontinuous.

In the configuration of upper branches, this plant agrees well with *P. scopulorum* HARVEY which is only known in the tetrasporic frond and briefly described and figured in KUETZING's Tab. Phyc. (1. c.). In this foreign species the upper branchlets seem to be erecto-adpressed and do not show such subfastigiato-corymbose manner as may be seen in many Japanese ones.

In the herbarium of YENDO, the writer compared this specimen with YENDO's ones named as *P. ferulacea* SUHR (Duplicate ones from Nakiri and the other from Enoshima, Shimoda, Batan) and came to the conclusion that this species is the same as these YENDO's plants, which should be identified with *P. scopulorum*. This species can be distinguished from *P. ferulacea* by the shortness of the frond and articulation, the incomplete dichotomous ramification and rather softness in the substance.

### **Polysiphonia Savatieri** HARIOT

Pl. III, 8, and Text-figs. 10–11.

Alg. de Yokoska, n. 43 (1891) p. 226; DE TONI, Syll. Alg. vol. 4 (1903) p. 889; TSENG, Mar. Alg. Hong Kong, VI. Polysiphonia (Papers Michigan Acad. Sci. Arts and Lett. vol. 29, 1944) p. 73, pl. 3, fig. 1.

Syn. *P. minutissima* HOLLENBERG, Polysiphonia on the Pac. Coast of North Amer. I. Oligosiphonia (1942) p. 781, fig. 21.

Syn. *P. aggregata* SEGI, Mar. Alg. Ise Bay, I (1944) p. 35, fig. 2.

Japanese name: *Hime-itogusa* (nov.).

Hab.: Omaezaki, Tōtōmi Prov.; Wagu, Shima Prov.; Shionomisaki, Kii Prov.; Aoshima, Hyūga Prov. (M. KUROGI); Kusaie Isl. and Palau Isl., Caroline Isls. (Y. YAMADA).

Distri.: Lower California, Mexico.

Fronds solitary, epiphytic on other algae, erect, fine, flaccid, small. *0.7–*

1 cm. high; filaments 255–285$\mu$ thick near the base, slightly prominent at the nodes, almost equally thick in each part, several times branched in decomposito-dichotomous manner with patent axils, gradually narrow axils upwards, attached by unicellular rhizoids at the base; rhizoids aggregated near the base, arising as outgrowths of the corner and centre of the pericentral cells, cut off by cross walls, one or two per segment, 1350–1875$\mu$ long, 45–75$\mu$ thick,

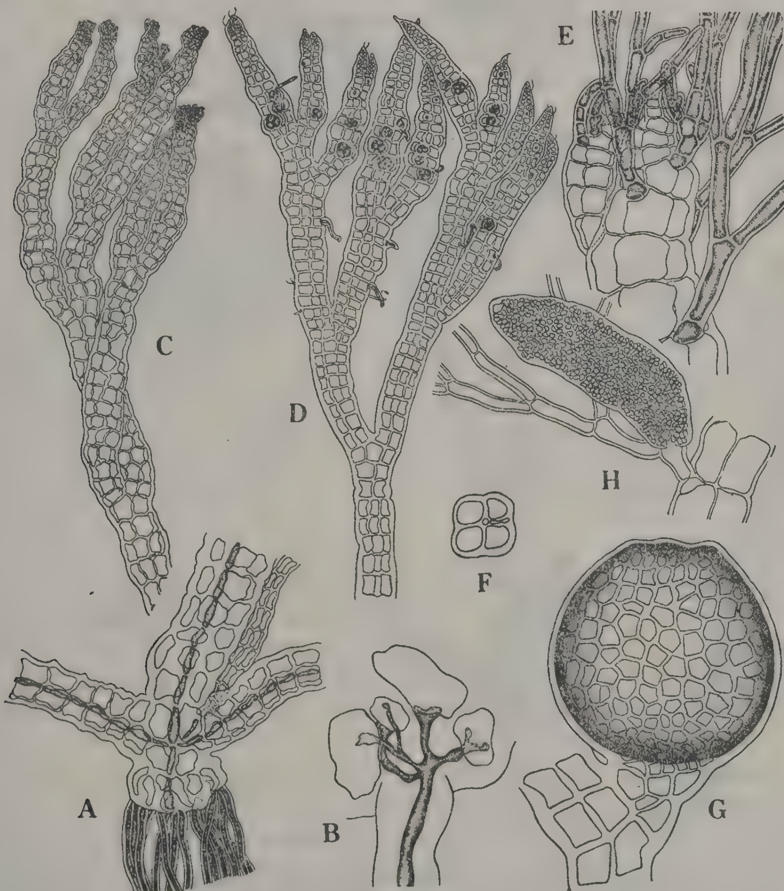



Fig. 10. *Polysiphonia Savatieri* HARIOT. A. Basal part of the frond showing endogenous creeping filaments. ×60; B. Rhizoid. ×200; C. Upper part of the tetrasporic branch. × 35. The specimen from Omaezaki; D. Upper part of the branch. ×35. The specimen from Shionomisaki; E. Tip of the branch. ×350; F. Transverse section of the basal part of the frond. ×ca. 75; G. Cystocarp. ×115; H. Antheridium. ×200.

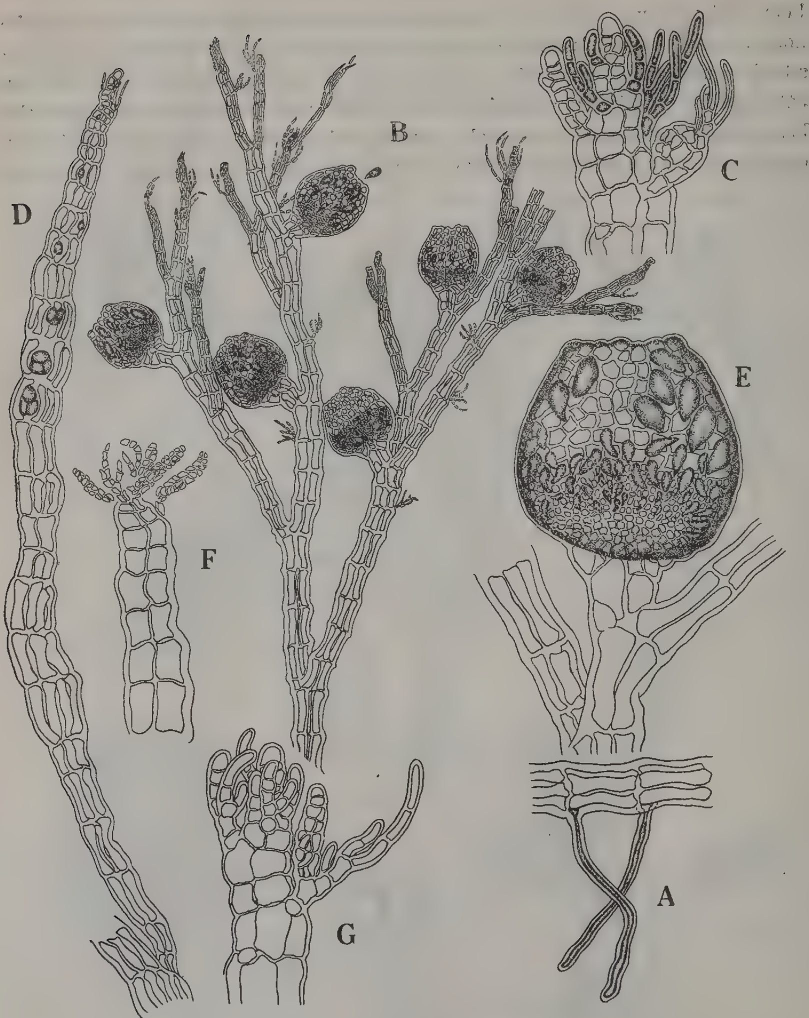



Fig. 11. *Polysiphonia Savatieri* HARIOT (?). The specimen from Palau. A. Rhizoids. ×60; B. Upper part of the cystocarpic branch. ×35; C. Tip of the branch bearing procarp. ×350; D. Branchlet with tetraspores. ×115; E. Cystocarp. ×115; F. Young antheridia. ×200; G. Tip of the branch bearing young antheridium. ×350.

gradually thicker and torulose at the end, provided with no discoid hapter at the tip; branches the lowest often endogenously arising at the base of erect

filaments horizontal, opposite, the rest exogenously arising in gradually narrow axils upwards, about 270$\mu$ thick, rather sparingly and distantly branched in fine branchlets with acute angles; branchlets arising at intervals 6–7 segments apart, about 225$\mu$ thick near the base; ultimate branchlets virgate, about 105$\mu$ thick, often furcate and obtuse at the apices; trichoblasts scantily arising near the apex of branches, one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, simple, about 45$\mu$ long, degenerate, leaving persistent scar-cells; branches not connected with trichoblasts in origin; articulations pellucid, almost ecorticated, short, about 0.3 times at the basal and middle, 0.8 times at the upper part of filaments; siphons 4 in number; tetrasporangia a few seriate on the upper part of branchlets, slightly prominent, discontinuous, globose or rather elliptical, $45 \times 60\mu$, tripartitely divided; cystocarps scattered on the upper part of branchlets, almost globose, relatively large, 360–$405 \times 375$–450$\mu$, pedicellate (1-celled). Colour redish brown. Specimens imperfectly adhering to paper in drying.

The present species was found growing on the frond of *Codium latum* SURINGAR (Omaezaki), *Grateloupia divaricata* OKAMURA (Aoshima), the vesicle of *Sargassum* sp. (Shionomisaki) and the node of *Chaetomorpha* sp. (Kusaie). This species appears to be rather common in the warmer sea of Japan. The writer interpreted this species in a broader sense. Above-mentioned diagnosis is based on the materials from Omaezaki. The fronds are considerably small and often irregularly branched. The lowest creeping filaments arise often endogenously at the base. The trichoblasts occur scantily on the apex of branches.

In the material from Shionomisaki the fronds are rather decumbent on the host. The tetraspores are sometimes a few disposed near the apex of torulose ultimate branchlets in a short spiral series, several arranged on the straight ones in a rather long spiral series. The cystocarps are broadly or narrowly globose in their shape. The short and robust rhizoids are numerously arising from basal decumbent branches and terminated by a broadly dilated hapter.

In the material from Aoshima the trichoblasts are well developed as shown Figure 10, E. They are 1–3 forked, 255–450$\mu$ long. The antheridia abundantly occur near the apices of branches attaining 45–52.5$\times$143–195$\mu$ in the longest (Fig. 10, H). They are provided with a short sterile tip (1-celled).

The specimen from Kusaie presents much finer form. The erect filament arises sometimes from a prostrate filament and sometimes directly from a decumbent base itself. It is fastened to the host by means of rhizoids which are rather short, one celled, and placed near the end of the pericentral cells. The articulations are much longer than those of Omaezaki and Shionomisaki

specimens.

Another specimen from Palau was found together with other small algae, as *Ceramium*, upon the frond of *Caulerpa* and *Zostera*. The trichoblasts occur on the various parts of the upper branches, besides the tip of branches. The peculiar cystocarp as shown in accompanying figures is one of the most characteristic features of this specimen. Its cystocarp is supported by very long pedicel (2–3 celled) and usually encompassed with an external coat of very small cells in abundance at the lower part of it. Owing to scanty material, however, the writer has some doubt whether this alga is identified with this species or not.

Judging from the brief original description of *P. Savatieri* HARIOT, the present specimens seem to agree with it on the whole, especially in the shape of cystocarp. To his regret, however, the writer has not been able to examine any authentic specimen. OKAMURA's plant under the name of *P. Savatieri* is to be identified with *P. japonica* as noted on p. 231 of this paper. At any rate, now full account of this species has been given by the writer with abundant figures, although it was never illustrated at all by the original and the other authors.

On the other hand, the materials at hand resemble well *P. tenerrima* KUETZING (Tab. Phyc. vol. 13, 1863, p. 28, figs. f–e) in external appearance, though the cystocarps are not provided with such narrow protuberance at the tip as may be seen in KUETZING's figure. Being compared with the photograph of the specimens from Istria, Adriatic Sea (Herb. Univ. Calif. No. 312054, Det. by SCHIFFNER as *P. sertularioides* var. *tenerrima*), this plant seems to be close to it also in general appearance. HAUCK considered *P. tenerrima* as a variety of *P. sertularioides* (Meeresalg. 1885, p. 220), but FALKENBERG described the former as a distinct species, separating from the latter by its small and epiphytic habit (Rhodomelac. 1901, p. 124). In *P. tenerrima* the mode of ramification perhaps seems to be the same as that of *P. sertularioides* in which the branches are connected with trichoblasts in the origin (cf. p. 194 of this paper). In the present species, on the contrary, this is not the case. This is what has led the writer to consider that it is more reasonable to identify this species with *P. Savatieri* in which the branches are replacing trichoblasts, than to *P. tenerrima*.

HOLLENBERG established a new species, *P. minutissima* HOLLENBERG characterized by "the minutive size and assurgent tufted habit of a tumble weed" (1. c. p. 782). Such characteristics, however, also may be seen in this specimen from Shionomisaki. The Californian plant seems to be identified with this species in general habit.

The minute specimens from Wagu agree rather well with this species,

except only a few following points. The branchlets are flabellate or densely fasciculato-corymbose. The trichoblasts are rather abundantly produced near the apex of branchlets. As noted above, the writer interprets *P. Savatieri* HARIOT in a broader sense and now considers that *P. aggregata* SEGI may better be placed with this species.

## Polysiphonia tongatensis HARVEY

Pl. IV–V, 1, and Text-figs. 12–13.

"Alg. Friend. Isl. n. 14"; KUETZING, Tab. Phyc. vol. 14 (1864) p. 14, pl. 41, figs. a–d; GRUNOW, Alg. Fidschi (1847) p. 48; Id., "Alg. Kelan p. 4"; DE TONI, Syll. Alg. vol. 4 (1903) p. 877; SETCHELL and GARDNER, Mar. Alg. Revillagigedo Isl. Exped. 1925 (in Proceed. Calif. Acad. Sci. Fourth Series, vol. 19, No. 11, 1930) p. 160 (as var. (?)).

Japanese name: *Benihossu* (nov.)

Hab.: Nagameike (Y. NAKAMURA) and Segamiike (K. YENDO), Koshikijima, Satsuma Prov.

Distri.: Tonga (Friendly) Isl.; New Caledonia; Tahiti Isl; Fiji Isl.

Fronds forming dense subglobose masses, entangled with each other, expanded to every directions, elongate, slender, fine, flaccid, 7–9 cm. high; filaments about 270–285$\mu$ thick near the base, prominent at the nodes, gradually attenuated upwards, with main axes indistinct, numerously branched in decomposito-subdichotomous manner with rather wide axils, provided with abundant, slender, adventitious branchlets; branches arising in every direction at irregular intervals, mostly 7–9–13 segments apart, distantly and sparingly branched, often issuing slender rhizoids at the middle part of them; branchlets arising in patent axils, often almost with right angles, rather simple or sparsely branched, upwards stretched to long, soft, fibriform ones; trichoblasts moderately developed near the apex of branches, one on each segment, arising in a left hand spiral with ¼ divergence, 1–3 forked, 60–120$\mu$ long, rather persistent, leaving conspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, 1–2 times as long as diam. near the basal, 2 times at the middle (sometimes 0.5 times), 1.4 times at the upper part of filaments; siphons 4 in number; tetrasporangia a few formed on the upper part of branchlets, continuous, prominent, elongate, elliptical, $45\times90\mu$, divided in tripartite manner; cystocarps and antheridia unknown. Colour redish brown. Specimens firmly adhering to paper in drying.

The present species was found forming a dense mass, entangled with

each other. In the specimens collected by K. YENDO in Segamiike the frond is very widely expanded to globose outline and the filament is slender, long, stretched to upwards. The rhizoids occur often near the middle part of branches. They are arising as outgrowths of the corner or centre of the pericentral cells, being cut off by cross walls. The articulations are generally longer than diam., but rarely they are much shorter and about 0.5 times as long as diam.

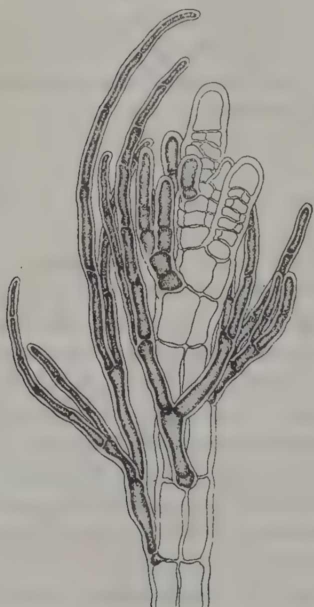


Fig. 12. *Polysiphonia tongatensis* HARVEY. Tip of the branch. ×350.

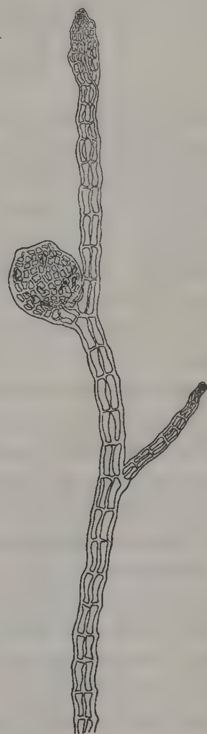


Fig. 13. *Polysiphonia tongatensis* HARVEY. var. (?). Cystocarp. ×35.

Comparing with the specimen of *P. tongatensis* HARVEY (Herb. Univ. Calif. No. 261338, Port Phaéton, Tahiti Isl. det. SETCHELL) and the figures of it given by KUETZING (l. c.), the present alga accords well with it in general. Furthermore, as compared with foreign specimens of *P. tongatensis* (Herb. Lenormand, Wagap, Nelle Calédonie, No. 2183) this plant agrees with them on the whole,

except only a few following points. The Oceanic specimens are blackish and small, 1.5–2.2 cm. in height and 135–150$\mu$ in thickness. The fronds show often 5 siphons besides 4 ones at the lower part of them.

DE TONI reported that *P. tongatensis* should be a synonym of *P. mollis* HOOK. et HARV. in Syll. Alg. (1. c.). According to the one Australian specimen (cystocarpic) and figures (KUETZING's Tab. Phyc. vol. 13, 1863, pl. 86) of *P. mollis*, however, this species is rather different from it in the ramification. But the other Australian specimen and original description of *P. mollis* show some likeness to *P. tongatensis*, so it is not easy to delimit clearly these two allied species.

There is another specimen which was collected by S. SAKAGUCHI in Seto, Kii Prov., resembling this species. In Seto specimen the fronds are epiphytic on other red alga, forming a tuft. They are 3.5–5 cm. high and rather sparsely branched. The cystocarps are ovato-globose (180×315$\mu$) with a broad mouth on the apices. This specimen seems to be closely related to *P. siamensis* MARTENS (Tange, Preuss. Exped. n. Ost. As. 1866, p. 31, pl. 7, fig. 1) and *P. uporensis* GRUNOW (Alg. Fidschi, 1874, p. 49). In the writer's opinion, however, it is reasonable to consider this alga as *P. tongatensis* var., as SETCHELL and GARDNER reported that "In case *P. tongatensis* HARV. and *P. siamensis* prove identical, HARVEY's name as published by KUETZING (Tab. Phyc. vol. 14, 1864, p. 14, pl. 41, figs. a-d) has priority. MARTENS' species, however, is rooting above and is said to have 4–6 pericentral cells." (1. c.).

## **Polysiphonia ferulacea** SUHR

Pl. V, 2, 3, and Text-fig. 14.

J. AGARDH, Spec. Alg. vol. 2 (1863) p. 980; Phyc. Bor. Amer. Fas. 7 (1897) No. 340; DE TONI, Syll. Alg. vol. 4 (1903) p. 892, vol. 6 (1924) p. 395; BOERGESEN, Mar. Alg. of Dan. West Ind. vol. 2 (1915–20) p. 277, figs. 277–280; OKAMURA, Nippon Kaisō Shi (1936) p. 829.

Syn. *P. breviarticulata* (non ZANARDINI) HARVEY, Ner. Bor. Amer. (1853) p. 36, pl. 16, B.

Syn. (?) *P. simplex* HOLLENBERG, Polysiphonia on the Pac. Coast of North Amer. I. Oligosiphonia (1942) p. 782, fig. 18.

Japanese name: *Bō-itogusa* (nov.).

Hab.: Samani, Hokkaido (H. HIROSE); Nomosaki, Hizen Prov. (T. TANAKA).

Distri.: Atlantic Coast of Mexico, North America; New Holland; California.

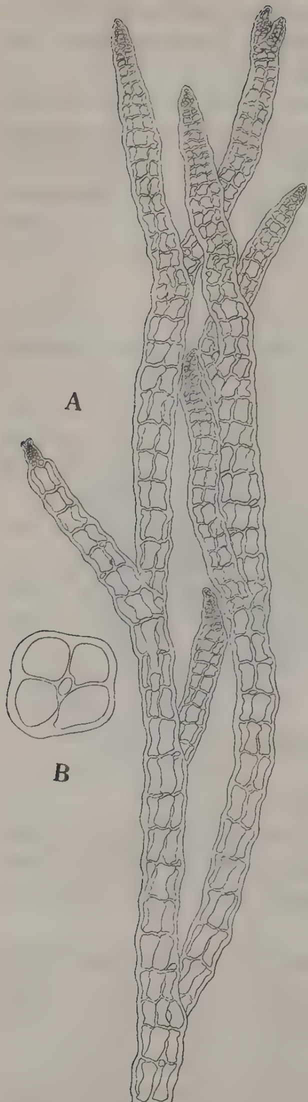



Fig. 14. *Polysiphonia ferulacea* SUHR. A. Upper part of the branch. ×35; B. transverse section of the basal part of teh frond. ×115.

Fronds elongate, slender, rather rigid, 3.5–4 cm. high, assurgent from intricate base; filaments 225–375$\mu$ thick near the base, gradually attenuated upwards, with main axes indistinct, below rather sparingly branched, above decomposito-dichotomously ramified in fastigiate manner, attached by unicellular rhizoids near the base; rhizoids arising at the corner of pericentral cells, cut off by cross walls, 270–600$\mu$ long, 45–60$\mu$ thick, sometimes provided with a discoid hapter at the end; branches arising exogenously at intervalls 5–7 or more segments apart, nude near the base, at the middle divided in similar branchlets with acute angles; branchlets simple or irregularly branched upwards, virgate, furcate or forcipate at the apices; ultimate branchlets subulate, not narrowed at the base, obtuse at the apices; trichoblasts unknown; scar-cells conspicuously present; articulations pellucid, ecorticated, about 0.7 times as long as diam. at the basal, almost equal to diam. at the middle and upper part of filaments; siphons 4 in number; reproductive organs unknown. Colour dark brown. Specimens not adhering to paper in drying.

The Samani specimen is rather coarse and fragile in the substance. The branchlets are often forked at their apices. This specimen accords rather well with the descriptions of *P. ferulacea* given by J. AGARDH, DE TONI and BOERGESEN (l. c.). Furthermore, as compared with foreign specimens of this species (Phyc. Bor. Amer. Fas. 7, 1897, No. 340, b; Herb. New York Bot. Gard., Rio Novo, Jamaica,

B. W. I., Presented by Mrs. WM. R. PITT) this Japanese one agrees well with them in general. But the articulations appear to be longer than those of the foreign ones.

The other specimens, without noting locality, form dense, large, subglobose mass. They are found associated with small *Corallina*. These specimens rather agree with the foreign specimens (Phyc. Bor. Amer. Fas. 7, 1897, No. 340, a; Algae marinae Indiae orientalis, det. and legit. BOERGESEN, No. 5862), though the filaments of the former ones are finer than those of BOERGESEN's one.

Full account of this species has been given by BOERGESEN (l. c.). According to his description, the trichoblasts are evidently arising one on each segment with ¼ divergence.

HOLLENBERG established a new species, *P. simplex* HOLLENBERG in l. c., which was unfigured on structural details. Judging from the description and photograph of his species, however, *P. simplex* seems to be identified with *P. ferulacea*. The abundant materials from Nomosaki agree well with it in general. According to HOLLENBERG, the distinguishable differences between *P. simplex* and *P. ferulacea* are only in the former's lower matted habit and slightly longer articulations than those of the latter. However, it is not easy to make a distinction between these two species. Unfortunately the writer has not been able to see any reproductive organ and trichoblast in these Japanese and foreign specimens, so remains a doubt in some degree.

## **Polysiphonia Yendoi** SEGI spec. nov.

Pl. VI, 1, 2, and Text-fig. 15.

Syn. *P. fibrata* (non HARVEY) YENDO, Notes on Alg. New to Japan, VIII (Bot. Mag. Tōkyō, vol. 32, 1918) p. 74; Okamura, Nippon Kaisō Shi (1936) p. 828.

Frondes cristas densas formantes, saxicolae, tenues, elongatae, flaccidae, fere membranaceae, 3.3–5 cm. altae, ex filamentis prostratis repentibus assurgentes; filamentis prostratis implicatis, 225–270 μ crassis, per rhizoidea unicellularia affixis; rhizoideis ex angulo vel centro cellularum pericentralium excrescentibus, per muros transversos non abscissis, communiter uno per segmentum, tenuibus, 300–975 μ longis, 45–75 μ crassis, discum terminalem ferentibus; filamentis erectis ex filamentis prostratis exogene ortis, 255 μ crassis prope besim, utrimque sensim attenuatis, cum axibus principibus distinctis, in nodis paulum prominentibus, subalternatim vel fere irregulariter ramosis; ramis exogene ln intervallis irregularibus, communiter (1)–5–7–8 segmentis separatis,

in angulis fere acutis cum axibus principibus orientibus, flexuosis; ramulis basi nudis, superiore subfasciculato-corymbosis ramosis; ramulis ultimis subulatis, paulum attenuatis ad basim, ca. 45–75 $\mu$ crassis in parte media, apice fere acutis; trichoblastis prope apicem modeste emittentibus, uno per segmentum, spiram laevam ¼ divergentem facientibus, delicatis, 1 furcatis, 180–240 $\mu$ longis, frequenter cicatricellulas inconspicuas relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis pellucidis, ecorticatis, ca. 1.6 plo diam. longioribus in parte basali, ca. 2.3 plo in parte media, ca. 2 plo in parte superiore axium primorum (paulum brevioribus diam. in parte superiore ramulorum); siphoniis 4; tetrasporangiis numerosis spiraliter in partibus superioribus ramulorum seriatis, continuis, eximie prominentibus, globosis, ca. 75 $\mu$ crassis, tripartite divisis; cystocarpiis numerosis sparsis in partibus superioribus ramulorum, late ovatis, 255–300 × 300–360 $\mu$, pedicellatis (1–2 cellulis suffultis). Color brunneus. Specimina exsiccatione chartae adhaerent.

Japanese name: *Yendō-itogusa.*

Hab.: Oshoro, Muroran (Y. NAKAMURA), Yoichi (J. TOKIDA), Shiokubi (S. NARITA), Okujiri Isl. (Y. HASEGAWA) and Rishiri Isl. (J. TOKIDA, Y. YENDO), Hokkaidō; Otairenkō, Aniwa Bay, Saghalien (K. MIYABE); Shirisawabe (Y. YENDO) and Bentenjima (Y. YAMADA, S. INOH), Mutsu Prov.; Kinkazan, Rikuzen Prov. (Y. YENDO); Oga peninsula, Ugo Prov. (S. NARITA).

Fronds forming dense tufts, saxicolous, slender, elongate, flaccid, rather membranaceous, 3.3–5 cm. high, assurgent from prostrate creeping filaments; prostrate filaments tangled, 225–270 $\mu$ thick, attached by unicellular rhizoids; rhizoids arising as outgrowths of the corner or centre of the pericentral cells, not cut off by cross walls, commonly one per segment, slender, 300–975 $\mu$ long, 45–75 $\mu$ thick, provided with a discoid hapter at the end; erect filaments arising exogenously from the prostrate filaments, 255 $\mu$ thick near the base, gradually attenuated on both sides, with principal axes distinct, slightly prominent at the nodes, branched in subalternate or rather irregular manner; branches arising exogenously at irregular intervals, commonly (1)–5–7–8 segments apart, rather at acute angles with the principal axes, flexuose: branchlets nude at the base, above branched in subfasciculato-corymbose manner; ultimate branchlets subulate, slightly narrow at the base, about 45–75 $\mu$ thick in the middle, rather acute at the tip; trichoblasts moderately developed near the apex, one on each segment, arising in a left hand spiral with ¼ divergence, delicate, 1 forked, 180–240 $\mu$ long, often leaving inconspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, about 1.6 times as long as diam. at the basal, about 2.3 times at the middle,

about 2 times at the upper part of primary axis (slightly shorter than diam. at the upper part of branchlets); siphons 4 in number; tetrasporangia numerously and spirally seriate on the upper parts of branchlets, continuous, extremely prominent, globose, about 75 $\mu$ diam., tripartitely divided; cystocarps numerously scattered on the upper parts of branchlets, broadly ovate, 255–300 $\times$ 300–360 $\mu$, pedicellate (supported by 1-2 celled stalk). Colour brown. Specimens adhering to paper in drying.

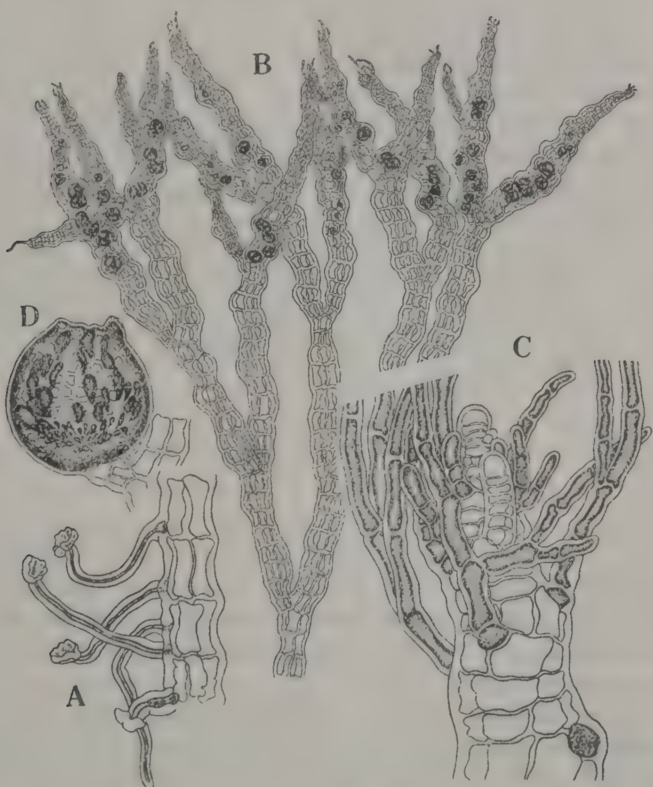



Fig. 15. *Polysiphonia Yendoi* SEGI. A. Rhizoids. $\times 35$; B. Upper part of the tetrasporic branch. $\times 35$; C. Tip of the branch. $\times 350$; D. Cystocarp. $\times 60$.

The new species was found forming a dense tuft, associated with small *Corallina*. It is rather commonly distributed in northern parts of Japan, especially in Hokkaidō.

In external appearance, it is very similar to *P. fibrata* (DILLWYN) HARVEY.

especially to the British specimen of it. However, the mode of the branching in origin will be most useful in distinguishing it from *P. fibrata.* In a foreign plant the branches are arising in connection with trichoblasts in origin (KNY, Axillarkno. Florid. 1873, p. 102, Taf. 1, figs. 10–13; OKAMURA, Nippon Kaisō Shi, 1936, p. 813), whereas in the Japanese one they are entirely replacing trichoblasts. As noted above (p. 178 of this paper), the writer also ascertained the former's important characteristic in some British specimens. In addition the length of articulation is much shorter in the present species than in HARVEY's description. HARVEY gave it as 4–8 times as long as diam. in the middle part of main axis, while the writer measured it as about 2.3 times. Being different from KUETZING's figure of *P. fibrata* (Tab. Phyc. vol. 13, 1863, pl. 100), the present species is lacking cortical layer throughout the frond.

In the Herbarium of YENDO and NARITA the writer compared the present specimens with the duplicate specimen (Shirisawabe, Mutsu Prov.) and the other ones (Oga Peninsula, Ugo Prov.; Shiokubi, Hokkaidō) of "*P. fibrata*" called by YENDO and came to the conclusion that this plant is exactly the same as YENDO's one, which should be identified with *P. Yendoi* instead of *P. fibrata.* Furthermore, comparing with the specimen of *P. fibrata* (Herb. Univ. Calif. No. 396728, collected in Tsugaru Strait and identified by K. YENDO), the specimen at hand agrees well with it in general.

## **Polysiphonia spinosa** (AG.) J. AGARDH

Pl. VI, 3.

Alg. Med. (1842) p. 140; Id., Spec. Alg. vol. 2 (1863) p. 1000; KUETZING, Spec. Alg. (1849) p. 833; Id., Tab. Phyc. vol. 14 (1864) pl. 20, figs. d-e; ARDISSONE, Phyc. Mediter. vol. I (1883) p. 409; HAUCK, Meeresalg. (1885) p. 230; DE TONI, Syll. Alg. vol. 4 (1903) p. 909.

Syn. *Rhodomela spinosa* AGARDH, Syst. Alg. (1824) p. 200.

Syn. *P. flexella* (non AGARDH) YENDO, Notes on Alg. New to Japan, V (Bot. Mag. Tōkyō, vol. 30, 1916) p. 261; OKAMURA, Nippon Kaisō Shi (1936) p. 832.

Japanese name: *Toge-itogusa* (nov.).

Hab.: Natsudomari-saki, Mutsu Prov. (Y. YAMADA).

Distri.: The coast of Adriatic, Dalmatian, Ligurian, Ionian Sea.

Fronds caespitose, epiphytic on other algae, forming an intricate mass, sometimes elongate and expanded to globose outline, thick, rigid, 4–7 cm. high. assurgent from intricate base; filaments about 340 $\mu$ thick near the base,

gradually attenuated upwards, dichotomously branched with wide angles, provided with numerous, distinct, spine-formed adventitious branchlets throughout the filaments, attached by unicellular rhizoids near the base; rhizoids arising as outgrowths of the corner of pericentral cells, not cut off by cross walls, sometimes aggregated, robust, short, about 225 $\mu$ long, about 75 $\mu$ thick, provided with a discoid hapter at the end; branches irregularly divaricated, remote, elongate, flexuose, the lower thick and densely covered with robust spine-formed branchlets, the upper thinner and with minute fine ones; branchlets secundly arising with acute angles, interspersed, simple or forked with wide angles near the apex; trichoblasts densely developed near the apex of adventitious branchlets; articulations subpellucid, corticated below (ecorticated above), prominent, short, almost about 0.5 times as long as diam. in the filament; siphons 4 in number; tetrasporangia a few produced on the branchlets, extremely prominent, globose, indistinctive in dividing manner. Colour dark redish brown. Specimens imperfectly adhering to paper in drying.

The present species was found growing on *Sargassum confusum* AG., entangling with each other. The most characteristic feature of the present species is possessing the spinose branchlets throughout the frond, which indicate at once the present species. A few cortical cells occur at the basal part of filament, but upwards they are not developed at all. The trichoblast differs in its quantity according to individuals. To his reget the writer has not been able to examine any anatomical detail and sexual reproductive organ in the present dried materials.

Judging from the descriptions and figures (KUETZING's Tab. Phyc. l. c.) of *P. spinosa* (AG.) J. AGARDH, the present plant agrees well with it in general. But the spine-formed branchlets are simple and not so much ramified as those of it. The articulations are mostly shorter than those of it.

On the other hand, the present plant also resembles the foreign specimen of *P. flexella* J. AGARDH from Adriatic Sea in some degree. In the writer's opinion, however, *P. spinosa* commonly seems to have tendency to be more robust, to have distinct spinose branchlet, being compared with other foreign specimens from Marseille and KUETZING's figure (Tab. Phyc. vol. 14, pl. 19, figs. d-f) on *P. flexella*.

For the present the writer adopted this name, *P. spinosa*, instead of *P. flexella*, considering the characteristics mentioned above. But sometimes it is not easy to make a distinction between these two allied species. It may be better to consider that these two species are combined in one species, according to further study. The writer regretfully has not been able to see any authentic specimen of *P. spinosa*.

YENDO's specimen named as *P. flexella* J. AGARDH (l. c.) seems to be the same as this plant, though the writer has not observed any specimen.

### Polysiphonia Harlandii HARVEY

Pl. VII, 1. and Text-fig. 16.

Charac. of new alg. (Proceed. Amer. Acad. vol. 4, 1859) p. 330; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 1063; DE TONI, Syll. Alg. vol. 4 (1903) p. 913; YAMADA, Notes on Japan. Alg. V (1933) p. 283, pl. 13, fig. 3; OKAMURA, Nippon Kaisō Shi (1936) p. 831; TSENG, Mar. Alg. Hong Kong, VI, Polysiphonia (Papers Michigan Acad. Sci. Arts and Lett. vol. 29, 1944) p. 78, pl. 4.

Japanese name: *Taiwan-itogusa.*

Hab.: Kelung, Formosa (Y. YAMADA).

Distri.: Hong Kong, South China Sea.

Fronds solitary or some tufted, epiphytic on other algae, thick, carnose, rather small, 3–4 cm. high, arising from basal disc; filaments 675–825$\mu$ thick near the base, slightly attenuated upwards, cylindrical, simple or sparingly branched, provided with numerous, adventitious branchlets, attached by unicellular rhizoids near the base; rhizoids numerously produced near the base, arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, one or often more on each segment, about 750$\mu$ long, about 45$\mu$ thick, sometimes provided with a discoid hapter at the end; branches arising near the basal part of filament, virgate, simple or di- or trichotomously forked on the middle part, nude below, above issuing several branchlets in every direction; branchlets exogenously arising at intervals 3 segments apart, short, nude at the base, above densely branched in fastigiate manner, furcate and acute at the tips; trichoblasts scantily developed near the apex, one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, simple or once forked, about 60–135$\mu$ long, leaving conspicuous scar-cells; branches not associated with trichoblasts in origin; articulations opake downwards, pellucid upwards, much corticated and tesselate, provided with a large secondary cell, short, about 0.2 times as long as diam. near the basal, about 0.5 times at the middle, about 0.4 times at the upper part of filaments; siphons 4 in number; tetrasporangia 3–5 spirally arranged in the upper parts of ultimate branchlets, prominent, verrucose, globose, about 45$\mu$ diam., tripartitely divided; cystocarps abundantly produced on the upper parts of ultimate branchlets, lateral, almost globose, 240–300 × 255–330$\mu$, long pedicellate (2–3 celled). Colour brownish red or violet. Specimens adhering to paper in drying except the basal part.

The most striking feature of the present species is that the cortical cells are arranged in tessellate manner. In the materials at hand the cystocarps were found abundantly, which are supported by rather long pedicels (2-celled stalks).

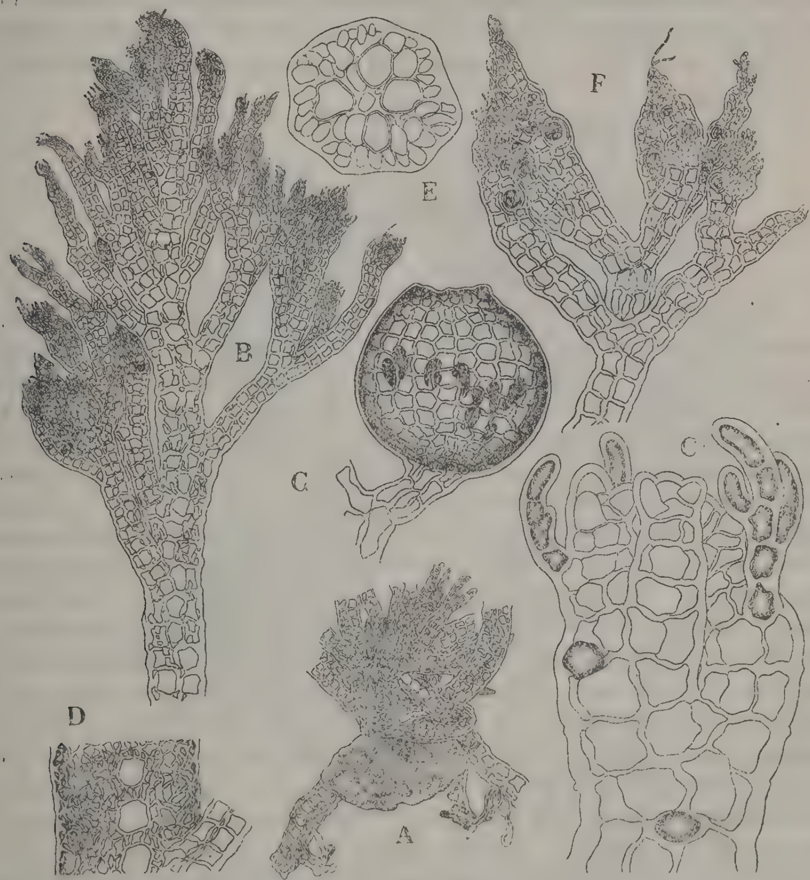



Fig. 16. *Polysiphonia Harlandii* HARVEY. A. Basal disc. ×35; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch. ×ca. 525; D. Basal part of the frond bearing cortical cells. ×35; E. Transverse section of the basal part of the frond. ×35; F. Upper part of the branchlet with tetraspores. ×60; G. Cystocarp. ×115.

This specimen was identified with *P. Harlandii* HARVEY by YAMADA, comparing with the original specimen in HARVEY's Herbarium at Dublin.

On the other hand, the present species shows much resemblance to *P.*

*polyphora* KUETZING which is figured in KUETZING's Tab. Phyc. vol. 14 (1864) pl. 32, figs. d-g. Perhaps KUETZING's plant may be the same as this HARVEY's one in general.

According to TSENG (l. c.), the present species is fallen into two forma, f. *typica* and f. *minutissima*. The present material belongs to the former. In Hong Kong specimens he noted the presence of "tufts of well-developed trichoblasts at the tips" (l. c.), while in Formosan ones this is not the case as noted above.

## Polysiphonia decumbens SEGI spec. nov.

Pl. VII, 2, and Text-figs. 17–18.

Frondes solitariae vel aliquanto cristatae, epiphyticae in alias algas, flaccidae, pusillae, 8–14 mm. longae, ex basi decumbentes; filamentis ca. 450$\mu$ crassis prope basim, cylindraceis, cum axibus principibus indistinctis, fere irregulariter dichotomo-ramosis, per rhizoidea abundantia affixis; rhizoideis ex cellulis corticatis excrescentibus, 1–2 cellulis, plerumque fere terminaliter ramosis, tenuibus, elongatis, 255–375$\mu$ longis, 23–45$\mu$ crassis, apices obtusos saepe prominentes ferentibus; ramis infimis horizontalibus et fere oppositis ad basim, reliquis in distantia parva supra basim divaricatis, basi nudis, supra alternatim vel secundatim ramosis; ramulis exogene in intervallis irregularibus orientibus, nudis ad basim, supra interdum dense subfastigiato-corymbosis ramosis; ramulis ultimis virgatis, leviter attenuatis ad basim, apice fere acutis; trichoblastis numerosis prope apicem ramorum emittentibus, uno per segmentum, spiram laevam ¼ divergentem facientibus, 1–3 furcatis, 450$\mu$ longis, deciduis, cicatricellulas persistentes relinquentibus; ramis trichoblastorum vicem; articulis opacis, infra corticatis (sed supra ecorticatis), brevibus, ca. 0.3 plo diam. longioribus in parte basali et media, ca. 0.4 plo in parte superiore filamentorum; siphoniis 4; tetrasporangiis 1–3 in ramulis torulosis ultimis, spiraliter seriatis, prominentibus, globosis, 45–75$\mu$ diam., tripartite divisis; cystocarpiis numerosis in ramulis orientibus, pro ratione plantae magnis, late urceolatis vel ovatis, 255–375 $\times$ 375$\mu$, pedicellatis (1-cellularibus), apice ostiolo lato donatis; antheridiis prope apicem ramorum aggregatis, ut unus ramus trichoblasti ortis, lanceolatis vel fusiformibus, 45–150 $\times$ 75–240$\mu$, cum apicibus sterilibus (1-cellularibus). Color fusco-nigrescens. Specimina exsiccatione firme chartae adhaerent.

Japanese name: *Ribon-itogusa.*

Hab.: Mihonoseki, Izumo Prov.

Fronds solitary or forming a few tufts, epiphytic on other algae, flaccid, dwarf, 8–14 mm. long, decumbent from a base; filaments about 450$\mu$ thick near the base, cylindrical, with main axes indistinct, rather irregularly branched in dichotomous manner, attached by abundant rhizoids at the base; rhizoids arising as outgrowths of the cortical cells, 1–2 celled, often branched near the end, slender, elongate, 255–375$\mu$ long, 23–45$\mu$ thick, provided with

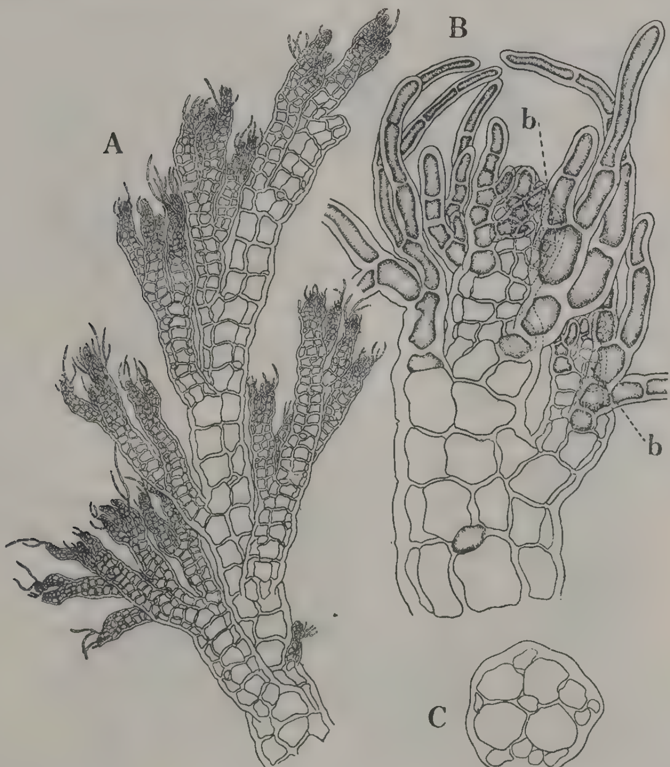



Fig. 17. *Polysiphonia decumbens* SEGI. A. Upper part of the branch. ×35; B. Tip of the b anch showing "trichoblast-unconnecting branches" (b). ×60; C. Transverse section of the basal part of the frond. ×60.

blunt and often swollen tips at the end; branches the lowest horizontal and almost opposite at the base, the rest divaricated at the short distance above the base, nude at the base, above alternately or secundly ramified; branchlets exogenously arising at irregular intervals, nude at the base, above sometimes densely branched in subfastigiato-corymbose manner; ultimate branchlets vir-

gate, slightly attenuated at the base, rather acute at the apices; trichoblasts numerously developed near the apex of branches, one on each segment, arising in a left hand spiral with ¼ divergence, 1–3 forked, 450 μ long, deciduous, leaving persistent scar-cells; branches replacing trichoblasts; articulations opake, corticated below (but ecorticated above), short, about 0.3 times as long

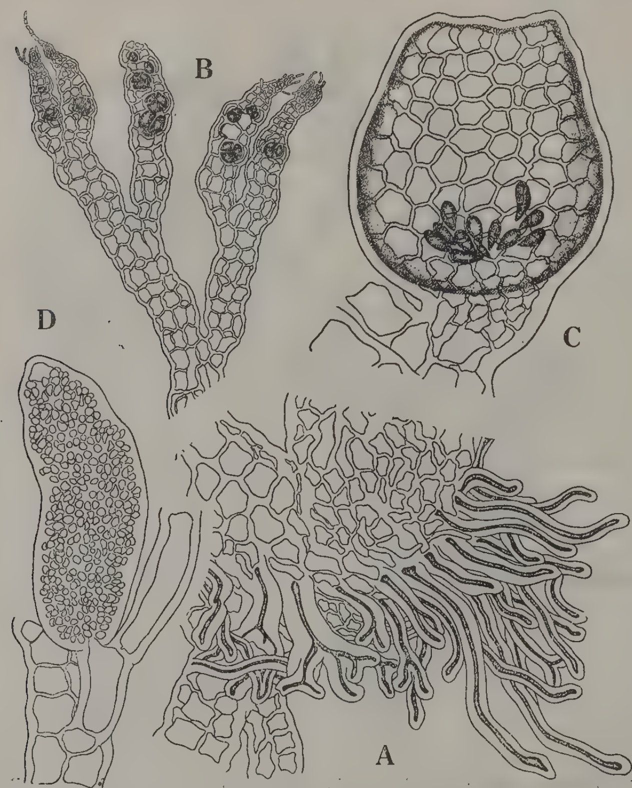



Fig. 18. *Polysiphonia decumbens* SEGI. A. Basal part of the frond. ×115; B. Upper part of the branchlet with tetraspores. ×115. C. Cystocarp. ×115; D. Antheridium. ×200.

as diam. at the basal and middle, about 0.4 times at the upper part of filaments; siphons 4 in number; tetrasporangia 1–3 formed on the torulose ultimate branchlets, arranged in a spiral series, prominent, globose, 45–75 μ diam., tripartitely divided; cystocarps numerously produced on the branchlets,

large compared with plant, broadly urceolate or ovate, 255–375 × 375 μ, pedicellate (1–celled), with very wide ostiole at the tip; antheridia aggregated near the apex of branches, arising as a primary branch of trichoblast, lanceolate or spindle shaped, 45–150 × 75–240 μ, with a sterile tip (1–celled). Colour brownish black. Specimens firmly adhering to paper in drying.

The new species was found abundantly growing on the frond of *Chondria* and *Chondrus* as an epiphyte. The fronds are usually decumbent on the host, but sometimes some of them are arising erectly. The basal part sends out many rhizoids by means of which the frond is inserted into the tissue of the host. The ramification is rather irregular, sometimes opposite, sometimes alternate or secund. The opposite branches are often found at the basal part of filament, as noted in the above diagnosis.

In the habit and the ramification of the frond, the new species closely resembles *P. Savatieri* HARIOT, especially its American species under the name of *P. minutissima* HOLLENBERG (Syn. of *P. Savatieri* HARIOT, Polysiphonia on the Pac. Coast of North Amer. I, Oligosiphonia, 1942, p. 781, fig. 21). Yet the presence of the abundant cortical cells at the basal part of filament, shortness of the articulation together with thickness of the filament separate the new species from that species. The rhizoid does not arise from the pericentral cell as in that plant, but in this alga it often issues from the cortical cell as far as could be observed. This process is quite reasonable from the morphological point of view, having cortical cells at the basal part of the frond. In addition, the cystocarp is broadly urceolate or ovate (not globose) and supported by a distinct pedicel composed of 1–(2) cell.

## **Polysiphonia nipponica** SEGI spec. nov.

Pl. VII, 3–VIII, 1, and Text-figs. 19–20.

Syn. *P. fibrillosa* (non HARVEY) OKAMURA, Nippon Kaisō Shi (1936) p. 832.

Frondes solitariae vel cristatae, non dense aggregatae, epiphyticae in alias algas, fruticosae, late expansae, tenues, gelatino-membranaceae, 7–9.5 cm altae, ex disco basali assurgentes; filamentis ca. 1125–1200μ crassis prope basim, cum axibus principibus distinctis, fere rectangulariter in quibusdam ramis principalibus parallelis partitis, pinnatim decomposito-alternatis ramosis, ramulis adventiciis numerosis minutis spiniformibus ornatis, per rhizoidea unicellularia affixis ad basim; rhizoideis ex cellulis corticalibus basalibus deorsum aggregatim excrescentibus, robustis, ca. 450–1125 μ longis, ca. 45–75μ crassis,

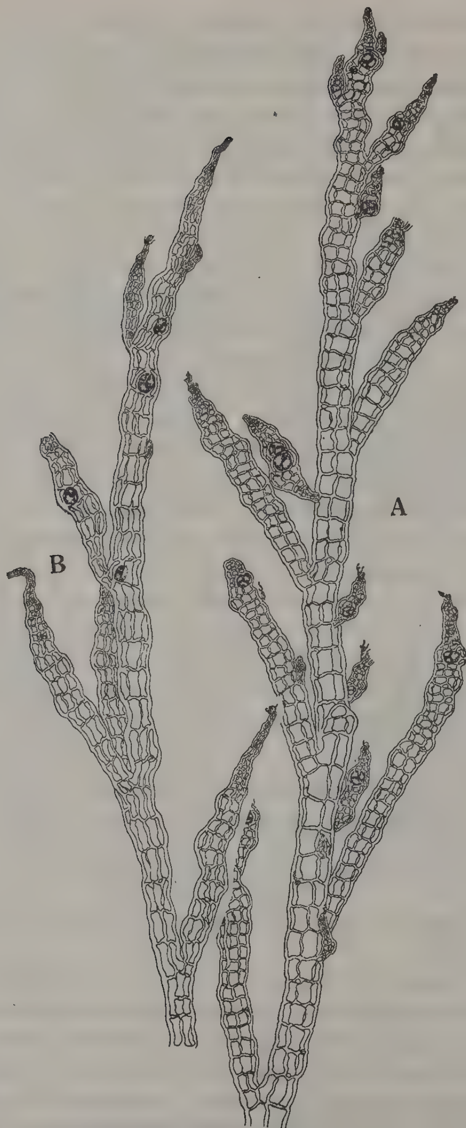



Fig. 19. *Polysiphonia nipponica* SEGI. A. Upper part of the tetrasporic branch. ×35. The specimen from Kaike; B. Upper part of the tetrasporic branch. ×35. The specimen from Shinmaiko.

interdum discum terminalem ferentibus; ramis exogene in intervallis irregularibus orientibus, in uno plano divaricatis, flexuosis, infimis longissimis, horizontalibus, axibus similibus, reliquis sursum sensim brevioribus, distanter lateraliter ramosis; ramulis sparsis, elongatis, flexuosis, patentibus, fere basi nudis, supra multifidis, apice fere obtusis; trichoblastis numerosis prope apicem ramorum emittentibus, uno per segmentum, spiram laevam $\frac{1}{4}$ divergentem facientibus, 1–3–(4) furcatis, ca. 306–375 $\mu$ longis, deciduis, cicatricellulas persistentes relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis opacis, inferne corticatis (sed superne ecorticatis), leviter prominentibus in nodis, ca. 0.6 plo diam. longioribus in parte basali, ca. 1.1 plo in parte media, ca. 1.4 plo in parte superiore filamentorum primorum (ca. 0.9 plo in parte media ramulorum); siphoniis 4; tetrasporangiis quibusdam spiraliter seriatis in partibus superioribus ramulorum, continuis, eximie prominentibus, globosis, 60–75 $\mu$ diam., tripartite divisis; cystocarpiis in partibus mediis et superioribus ramulorum sparsis, ovato-globosis, 315–420×330–465$\mu$, breviter pedicellatis, apice lato ostiolo donatis. Color brunneus. Specimina exsiccatione chartae non adhaerent

Japanese name: *Nippon-itogusa.*

Hab.: Kaike, Hōki Prov.; Komi, Owari Prov.; Shiotate Isl., Izumo Prov. (S. TAKAGI); Lake Saloma, Hokkaidō (K. IWAMOTO).

Fronds solitary or tufted, not densely aggregated, epiphytic on other algae, bushy, widely spreading, slender, gelatino-membranaceous, 7–9.5 cm. high, assurgent from basal disc; filamentis about 1125–1200$\mu$ thick near the base, with main axes distinct, parted into several paralleled principal branches in almost right angles with main axes, pinnately branched in decomposito-alternate manner, provided with numerous, minute, spine-formed adventitious branchlets, attached by unicellular rhizoids at the base; rhizoids aggregately arising as lower extensions of the cortical cells at the base, robust, about 450–1125$\mu$ long, 45–75$\mu$ thick, provided with a discoid hapter at the end; branches arising exogenously at irregular intervalls, divaricated almost on one plane, flexuose, the lowest longest, horizontal, similar to axes, the rest shorter above, branched in rather distant lateral branchlets; branchlets scattered, elongated, flexuose, patent, rather nude at the base, above multified, rather obtuse at the apex; trichoblasts numerously developed near the apex of branches, one on each segment, arising in a left hand spiral with $\frac{1}{4}$ divergence, 1–3–(4) forked, about 306–375$\mu$ long, deciduous, leaving persistent scar-cells; branches not associated with trichoblasts in origin; articulations opake, corticated below (but ecorticated above), slightly prominent at the node, about 0.6 times as long as diam. at the basal, about 1.1 times at the middle, about 1.4 times at the upper part of main filaments (about 0.9 times at the middle part

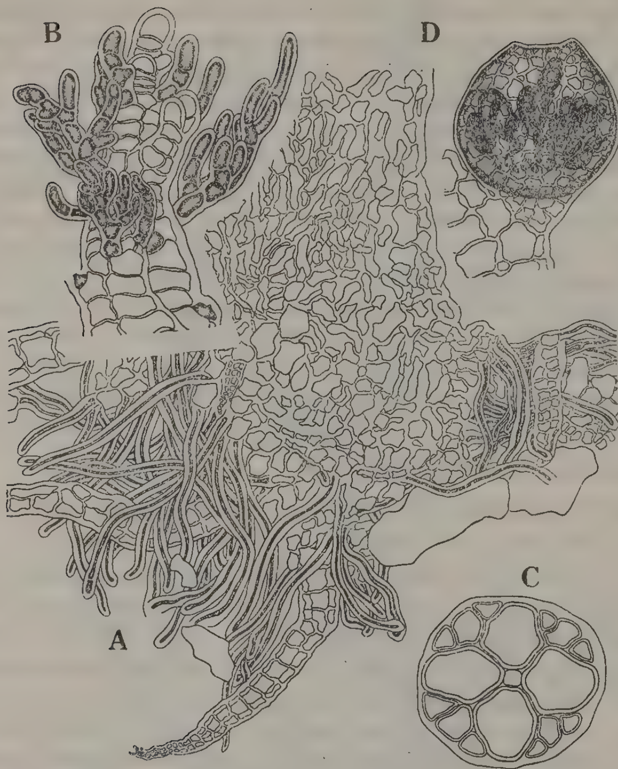



Fig. 20. *Polysiphonia nipponica* SEGI. A. Basal part of the frond. ×35; B. Tip of the branch. ×60; C. Transverse section of the basal part of the frond. ×35; D. Cystocarp. × 60.

of branchlets); siphons 4 in number; tetrasporangia several spirally seriate on the upper part of branchlets, usually continuous, extremely prominent, globose, 60–75 $\mu$ diam., tripartitely divided; cystocarps scattered on the middle or upper part of branchlets, ovato-globose, 315–420×330–465$\mu$ shortly pedicellate, with wide ostiole at the tip. Colour brown. Specimens not adhering to paper in drying.

The present species was found growing on the frond of *Grateloupia filicina* (WULF.) J. AGARDH. It is characterized by issuing densely short, spine-form adventitious branchlets throughout the frond. As mentioned in above

diagnosis, in most of the specimens at hand the fronds are branched in several horizontal main branches with percurrent axes, but in some ones they are divaricated without such percurrent main axes.

The material from Komi appears to be more coarse and lighter than that from Kaike. This plant may always be distinguished to the eye by its straw-like or rather light brownish colour when growing. The abundant materials were found on rather muddy bottom in low water mark in somewhat exposed places where fresh water is mingled with salt water. The articulations are considerably longer than those of Kaike plant. The trichoblasts are rather regenerated. The tetraspores are produced a few on the upper part of branchlets discontinuously.

Judging from the descriptions and figures (HARVEY, Phyc. Brit. 1846–51, pl. 302; TAYLOR, Mar. Alg. Northeast. coast of North Amer. 1937, p. 364, pl. 56, fig. 9, pl. 57, figs. 1–5; KYLIN, Rhodo. schwed. Westkueste, 1944, p. 83, fig. 76) and comparing with the foreign specimens (Flora suecica, I hafvet. Bohuslaen. Aug.; Phyc. Bor. Amer. Fas. 25, 1905, No. 1244; Univ. Calif. No. 95214, Algae of Massachusetts, Washed ashore, Woods Hole, W. A. S. 234) of *P. fibrillosa* GREVILLE, this plant resembles it much in external appearance. But this alga differs from it in the type of origin of the branches, for TAYLOR (l. c.) and KNY (Axillarkno. Florid. 1873, p. 104, Taf. 1, figs. 14-15) maintain that in *P. fibrillosa* they arise on the bases of certain of the trichoblasts, which they surely do not on *P. nipponica.*

The discussions have been made by HARVEY (l. c.), ROSENVINGE (Mar. Alg. Denmark III, 1923–24, p. 427) and KYLIN (l. c.) on the differences between *P. fibrillosa* and *P. violacea.* ROSENVINGE described the former species as a form of the latter. In some cases it is not easy to make a distinction between the fomer species and the latter one as noted by him. But it seems to the writer more reasonable to separate the former species from the latter one than to combine them into one species, according to KYLIN's opinion as follows: "Die in Rede Stehende Art ist mit *Polysiphonia violacea* nahe verwandt, ist aber etwas groeber, weniger schleimig und haftet daher weniger fest am Papier als diese. Besonders ist *P. fibrillosa* durch ihren Reichtum an kleinen verzweigten Zweigbuescheln gekennzeichnet" (l. c.).

**Polysiphonia novae-angliae** TAYLOR

Pl VIII, 2, and Text-fig. 21.

Notes on North Atlantic Mar. Alg. I (Papers Michigan Acad. Sci. Arts and Lett. vol. 22, 1937) p. 232, pl. 26–27, figs. 2–5; Id., Mar. Alg. Northeast. coast of North Amer. (1937) p. 366, pl. 58, figs. 6–10, pl. 59, figs. 5–6.

Japanese name: *Nagatsubo-itogusa* (nov.).

Hab.: Okujiri Isl., Hokkaidō (Y. HASEGAWA).

Distri.: Northeastern coast of North America.

Fronds forming more or less pyramidal tufts, moderately soft, fragile, spongy, 7–11.3 cm. high, arising from scutate discs; filaments 600–900 $\mu$ thick near the base, with main axes distinct, straight, cylindrical, alternately branched and with a few branchlets below, above densely and finely branched, furnished with short adventitious branchlets, attached by unicellular rhizoids at the base; rhizoids aggregated near the basal disc, arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, sometimes robust, usually 495–675 $\mu$ long, 60 $\mu$ thick, sometimes provided with lobed tips; branches irregularly and exogenously arising in non constant interval of segments, widespreading, elongate, flexuose, branchlets nude at the lower part, upwards densely branched in subfasciculate manner, slightly attenuated on both sides, obtuse and simple or furcate at the apices; trichoblasts numerously arising near the apex of branchlets, one on each segment, arising usually in a left hand, sometimes in a right hand spiral with ¼ divergence, 3 forked, about 255$\mu$ long, delicate, leaving persistent scar-cells; branches not associated with trichoblasts in origin; articulations pellucid above, opake below, much corticated below (ecorticated above), about 0.3 times as long as diam. at the basal, about 2 times at the middle, slightly shorter than diam. at the upper part of main axes; siphons 4 in number; tetrasporangia disposed on torulose branchlets in longitudinal series, occupying the middle parts of branchlets, continuous or interrupted, prominent, elliptical or globose, 75 $\mu$ diam., tripartitely divided; cystocarps numerously scattered on the middle parts of branchlets, elongato-urceolate, $345 \times 495\ \mu$, shortly pedicellate, with a wide mouth at the apices; antheridia numerously produced on the apex of branchlets, arising as a primary branch of trichoblasts, cylindrical or spindle shaped, $45 \times 150\mu$ with a short sterile tip. Colour dark purplish red. Specimens adhering to paper in drying.

In some small specimens at hand the frond was found growing on *Colpomenia*. It has such substance as noted by TAYLOR "moderately soft in texture but spongy rather than slippery". The elongato-urceolate cystocarp

is one of the most distinct characteristics of this species. In the present materials the trichoblasts are commonly arising in a left hand spiral with ¼ divergence, but sometimes they occur in a right hand spiral with it as shown in Figure 21, D.

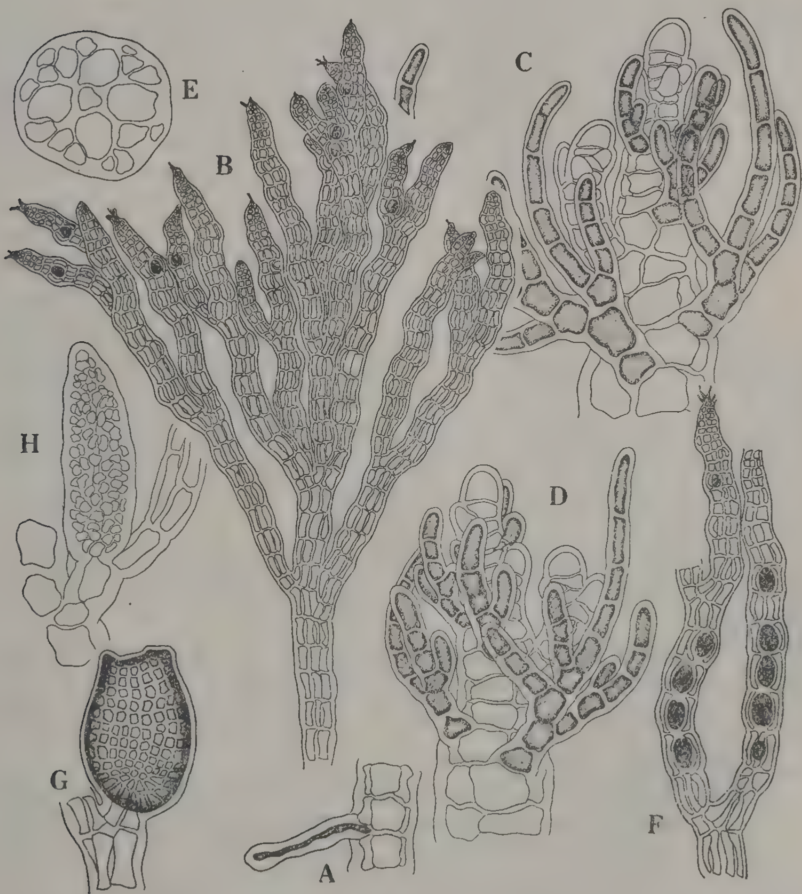



Fig. 21. *Polysiphonia novae-angliae* TAYLOR. A. Rhizoid. ×60; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch with trichoblasts spiralling to the left. ×300; D. Tip of the branch with trichoblasts spiralling to the right. ×300; E. Transverse section of the basal part of the frond. ×60; F. Upper part of the branchlet with tetraspores. ×60; G. Cystocarp. ×60; H. Antheridium. ×200.

Judging from the description and figures of *P. novae-angliae* TAYLOR given by the original author (l. c.), the present specimens agree quite well with it, especially in the shape of cystocarps. In the present plant, however, the fronds are not so widely expanded to globose outline as may be seen in TAYLOR's figure. According to the original author, this species is rather variable in aspect. In external appearance, the present species rather approaches the photograph of *P. violacea* (Herb. Univ. Calif. No. 95345, Algae of Calif. floating, Monterey, W. A. S. 1636) than foreign specimens of it (Phyc. Bor. Amer. Fas. 12, 1899, No. 595). This species is very similar to *P. violacea* in outwards appearance, but the branches replacing trichoblasts will be most useful in distinguishing it, as noted by TAYLOR.

### Polysiphonia japonica HARVEY

Pl. VIII, 3, and Text-fig. 22.

In PERRY "Narrat. of the Exped. of an Amer. Squadr. to the China Sea and Japan, 1852-4 (Washington 1856) vol. 2, p. 331"; MARTENS, Tange, Preuss. Exped. n. Ost. As. (1886) p. 133; DE TONI, "Phyc. Japon. (1895) p. 33, n. 93"; Id., Syll. Alg. vol. 6 (1924) p. 393; GEPP, Chinese Mar. Alg. (in Journ. of Bot. vol. 42, 1904) p. 163, pl. 460, figs. 4–6; MAZZA, "Saggio n. 283"; INAGAKI, Osyorowan no Kaisankōsōrui (1933) p. 63; OKAMURA, Nippon Kaisō Shi (1936) p. 830; NAGAI, Mar. Alg. Kurile Isl. II (1941) p. 228.

Syn. *P. mollis* (non HOOKER et HARVEY) ? YENDO, Notes on Alg. New to Japan, V (Bot. Mag. Tōkyō, vol. 30, 1916) p. 261; OKAMURA, Nippon Kaisō Shi (1936) p. 829.

Syn. *P. violacea* (non GREVILLE) YAMADA, Mar. alg. Mutsu Bay, II (1928) p. 524, fig. 18; OKAMURA, Nippon Kaisō Shi (1936) p. 833.

Syn. *P. Savatieri* (non HARIOT) OKAMURA, Nippon Kaisō Shi (1936) p. 830.

Japanese name: *Kiburi-itogusa*

Hab.: Shinmaiko, Owari Prov.; Koromoura (Y. YENDO) and Ikawatsu, Mikawa Prov.; Bentenjima (S. NARITA) and Omaezaki, Tōtōmi Prov.; Susaki, Izu Prov. (Y. YAMADA, Y. NAKAMURA); Kosagawa (T. MURAOKA) and Tobishima (A. HIROHASHI), Ugo Prov.; Futagojima, Mutsu Prov. (Y. YAMADA); Oshoro, Hakodate (J. TOKIDA, T. MORITAKE), Muroran (J. TOKIDA, Y. NAKAMURA), Otaru (J. TOKIDA), Zenibako (S. AKIYAMA), Esashi (Y. YAMADA), Y. NAKAMURA, A. KARAKAWA), Rushiya, Shiretoko Peninsula (Y. YAMADA), Rishiri Isl. (J. TOKIDA, K. INAGAKI) and Yunohama, Okujiri

Isl. (Y. HASEGAWA), Hokkaidō; Shikotan Isl. (S. KAWABATA) and Kunashiri Isl. (M. NAGAI), Kurile Isls; Hirochi, Chishiya, Nobori, Kaibatō and Honto, Saghalien (J. TOKIDA).

Distri.: Various Parts of Japan.

Fronds solitary or tufted, epiphytic on other plants, expanded to semiglobose outline, slender, elongate, rather rigid, 4.2–5 cm. high arising from discoid base; filaments 360-450μ thick near the base, usually without percurrent axes, subtetragonal below, cylindrical above, much branched in a decomposito-dichotomous manner, inferior thick, nude, divaricating or patently branched, superior gradually attenuated, acutely ramified, provided with some adventitious branchlets, attached by uni- or bicellular rhizoids; rhizoids numerously arising at the basal disc, aggregated, arising as extensions of the cortical cells, 300–375μ long, 45–60μ thick, sometimes provided with a discoid hapter at the end; branches inferior issuing at right angles, superior irregularly or alternately arising at gradually narrow axils, at intervals 5–6 segments apart, elongate, flexuose, below nude, above laterally beset with rather straight, multified, penicillate branchlets, arranged in fastigiate manner with acute angles; ultimate branchlets about 60μ thick, subulate, not attenuated at the base, obtuse at the apices; trichoblasts moderately developed near the apex of branches, arising one per segment in a left hand spiral with ¼ divergence, 1–3 forked, about 105–405μ long, deciduous, leaving scar-cells; branches replacing trichoblasts; articulations pellucid upwards, opake downwards, corticated below (ecorticated above), about 0.5 times as long as diam. near the basal, about 1.3 times at the middle, about 1.5 times at the upper part of filaments (0.6 times at the middle part of branchlets); siphons 4 in number; tetrasporangia 6–9 produced on the middle parts of ultimate and penultimate branchlets, spirally arranged in a long series, relatively small, elliptical and 60×90μ, or globose and 75μ diam., tripartitely divided; cystocarps numerously scattered on the branchlets, broadly ovate, or almost globose, about 300×300μ, shortly pedicellate; antheridia numerously developed near the tip of branches, arising as a primary fork of trichoblasts, lanceolate, 60×165μ, with a short sterile tip. Colour redish brown. Specimens adhering to paper in drying.

The present species was found very commonly along the coast of Japan, growing abundantly on *Zostera*, *Laminaria*, *Grateloupia* etc. The fruticose appearance and dichotomous branching at the lower part of the frond are the striking characteristic of this species. The plant is rather changeable in the aspect.

The abundant materials from various parts of Japan agree rather well

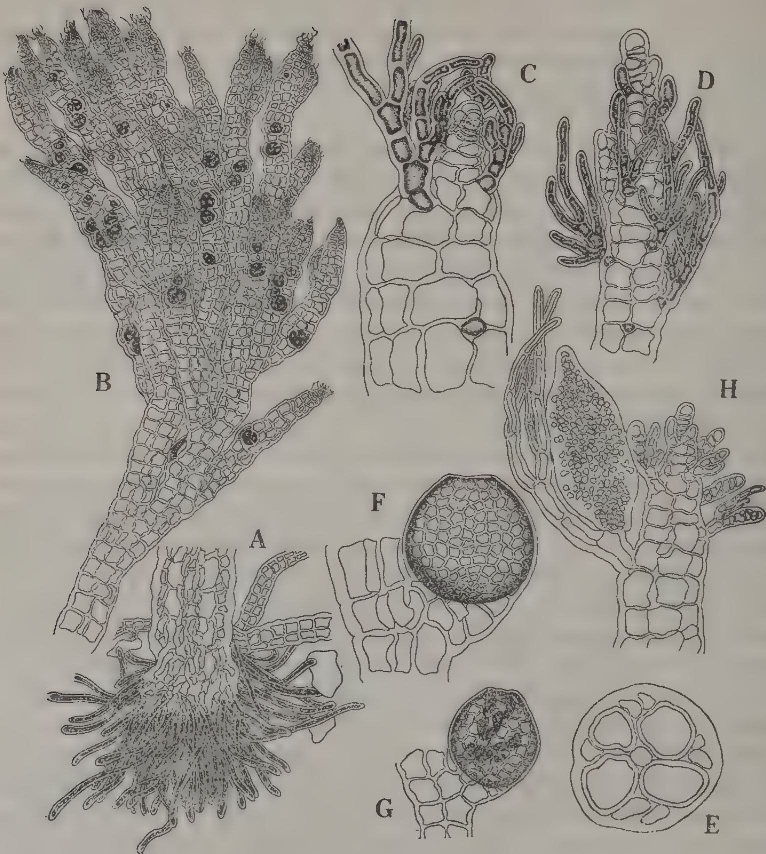



Fig. 22. *Polysiphonia japonica* HARVEY. A. Rhizoids. ×35; B. Upper part of the tetrasporic branch. ×35; C. Tip of the branch. ×350. The specimen from Oshoro; D. Tip of the branch. ×200. The specimen from Shinmaiko; E. Transverse section of the basal part of the frond. ×60; F–G. Cystocarps. ×60; H. Antheridium. ×200.

with the descriptions and figures of *P. japonica* given by DE TONI, GEPP. (l. c.).

The material from Shinmaiko shows such characteristics as mentioned in above diagnosis. It was found growing on *Zostera marina*. The cystocarpic fronds are branched in regular dichotomous manner with wide axils at the

lower part of them, assuming semiglobose outline, but the tetrasporic ones are sometimes laxly ramified with indistinct percurrent axis and terminated in alternate fine ultimate branchlets, sometimes acutely branched with it and ended in fasciculato-corymbose branchlets.

The material from Ikawatsu was found growing on *Grateloupia*. It represents blackish in colour. The plant in April is almost 4–6 cm. high and irregularly branched, showing fruticose appearance, but that in summer is about 3–4 cm. high and divaricated downwards, upwards expanded to flabellate outline. The former has abundantly subulate branchlets near the apex of the frond.

The material from Omaezaki was found growing on *Grateloupia*. The frond is very small, attaining only to 0.8–2.5 cm. high. It is not so densely ramified as the materials from above mentioned locality.

The material from Oshoro was found growing on *Laminaria*. In the transverse section of the lower part of filament the secondary subsidiary cell can be seen clearly, as noted by GEPP. As far as could be observed, however, the branch is not alternate as in GEPP's plant, but secund.

In external appearance sometimes the present species shows a striking resemblance to *P. violacea*, being compared with several foreign specimens, but it differs from the latter by the mode of branching in origin. In the latter species the branches arise on the bases on certain of the trichoblasts (cf. p. 178, 234 of this paper), while in this species such characteristic can not be observed at all.

On the other hand it seems that this plant rather approaches *P. elongella* HARVEY, judging from only the description and figures given by HARVEY (Phyc. Brit. 1846–51, pl. 146) and KUETZING (Tab. Phyc. vol. 14, 1864, pl. 7). It is not easy to separate the former species clearly from the latter one. The writer throws doubt on occuring *P. elongella* in Japan, though OKAMURA reported its presence (Nippon Kaisō Shi, 1936, p. 831).

YAMADA's specimen referred to *P. violacea* GREVILLE (l. c.) is related to this species, examing his specimen from Futagojima.

YENDO described the Owari specimens calling *P. mollis* HOOKER et HARVEY (?) and reported the absence of cortical cells in them (l. c.). In Herb. YENDO, OKAMURA, NARITA, however, the writer's examination of them reveals the presence of cortical cells distinctly at the basal part of the frond. His Owari specimens resembling *P. violacea* in external appearance are perhaps the same as this species, though they are scanty and rather fragmentary. On the other hand they resembles *P. nipponica* SEGI in some degree, but they differs much from *P. mollis* as compared with Australian specimens of it.

OKAMURA's plant under the name of *P. Savatieri* HARIOT (l. c.) is to be

identified with *P. japonica*. Examing his specimen (Herb. OKAMURA, Ex. Herb. NARITA, Bentenjima, Tōtōmi Prov., Coll. S. NARITA, Det. K. YENDO), the writer detected clearly the presence of some cortical cells near the basal part of the frond, which is one of the most distinctive characteristics of this species. The ramification is also different from that of *P. Savatieri*.

## Polysiphonia akkeshiensis SEGI spec. nov.

Pl. IX, 1–3, and Text-figs. 23–24.

Frondes solitariae, epiphyticae in alias algas, tenues, elongatae, laxe subflabellatim expansae, flaccidae, 3.5–5.8 cm. altae; filamentis 525$\mu$ crassis prope basim, sursum sensim attenuatis, cum nullis axibus principibus, infra sparsis distanter latiangulariter decomposito-dichotomis, supra dense subalternatim ramosis; ramis in intervallis irregularibus orientibus, erectis, patentibus, infimis longissimis, sursum sensim brevioribus, tota circumscriptione pyramidatis, infra omnino nudis, supra fere late axillaribus dense ramosis; ramulis ultimis virgatis, emaciatis, ca. 45$\mu$ crassis, basi non attenuatis, apice obtusis; trichoblastis modeste prope apicem ramulorum emittentibus, uno per segmentum, spiram laevam $\frac{1}{4}$ divergentem facientibus, tenuibus, elongatis, simplicibus vel 1 furcatis, ca. 75$\mu$ longis, deciduis, frequenter cicatricellulas inconspicuas relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis pellucidis, infra corticatis (supra ecorticatis), ca. 0.6 plo diam. longioribus in parte basali, ca. 2.6 plo in parte media, ca. 1.6 plo in parte superiore filamentorum; siphoniis 4; tetrasporangiis ignotis; cystocarpiis sparsis in ramulis, non aggregatis, anguste globosis vel ovatis, 255–270$\times$300–345$\mu$, brevissime pedicellatis; antheridiis ex secundo nodo trichoblasti orientibus, cylindraceis, ca. 45$\times$165$\mu$, interdum cum apice sterile unius aut plurium cellulorum. Color fuscus. Specimina exsiccatione chartae adhaerent.

Japanese name: *Akkeshi-itogusa.*

Hab: Lake Akkeshi (H. HIROSE) and Kojima (Y. HASEGAWA), Hokkaidō.

Fronds solitary, epiphytic on other algae, fine, elongate, laxly expanded to subflabellate outline, flaccid, 3.5–5.8 cm. high; filaments 525$\mu$ thick near the base gradually attenuated upwards, with no principal axes, below sparsely and distantly branched in decomposito-dichotomous manner with wide angles, above densely branched in subalternate manner; branches arising at irregular intervals, straight, patent, the lowest longest, gradually shorter upwards, on the whole giving pyramidal outline, entirely nude below, above densely bran-

ched with rather wide axils; ultimate branchlets virgate, emaciated, about 45$\mu$ diam., not attenuated at the base, obtuse at the tip; trichoblasts moderately developed on the apex of branchlets, one on each segment, arising in a left

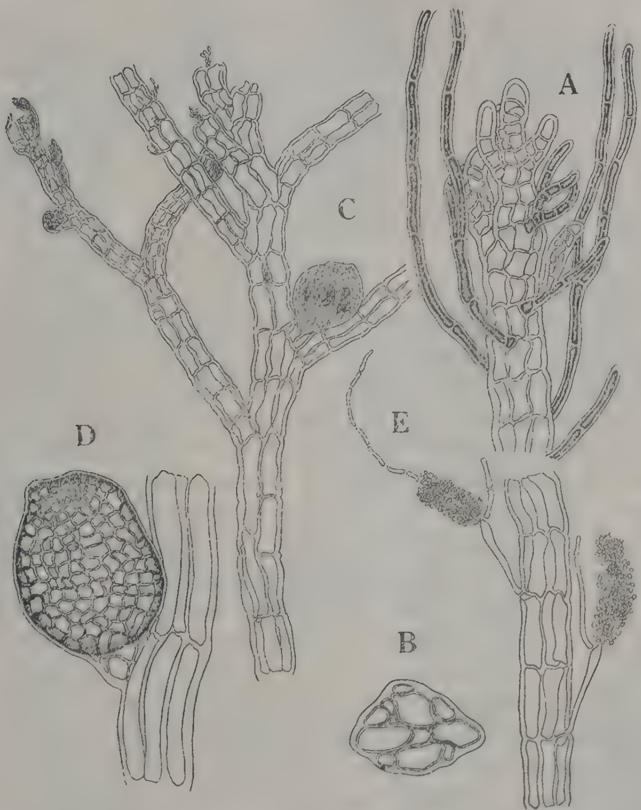



Fig. 23. *Polysiphonia akkeshiensis* SEGI. A. Tip of the branch. ×ca. 280; B. Transverse section of the basal part of the frond. ×60; C. Upper part of the cystocarpic branch. ×35; D. Cystocarp. ×115; E. Antheridia. ×115.

hand spiral with $\frac{1}{4}$ divergence, slender, elongate, simple or 1 forked, about 75$\mu$ long, deciduous, often leaving inconspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, corticated below (ecorticated above), about 0.6 times as long as diam. near the basal, about 2.6 times at the middle, about 1.6 times at the upper part of filament; siphons 4 in number;

tetrasporangia unknown; cystocarps scattered on the branchlets, not aggregated, narrow globose or ovate, 255–270×300–345$\mu$, very shortly pedicellate; antheridia arising from second node of trichoblast, cylindrical, about 45×165$\mu$, sometimes with a long sterile tip of one to several cells. Colour brownish. Specimens adhering to paper in drying.

The new species was found growing on the frond of red alga. It was collected by Dr. H. HIROSE in Lake Akkeshi which contains salt water. The frond is slightly corticated near the base, upwards diminishing in its number of cortical cells. The cystocarps are rather variable in shape. Sometimes they appear to be narrowly ovate as figured and sometimes they are broadly urceolate. The antheridia arise as primary branches of trichoblasts and they are terminated with long sterile tips (2–3 celled).

In outward appearance, this species is evidently allied to ***P. violacea*** (ROTH) GREVILLE. But the former species can be distinguished most clearly from the latter one by the fact that in ***P. violacea*** the branches arise on the bases of certain of the trichoblasts, as mentioned by FALKENBERG (Rhodomelac. 1901, p. 116), while in P. akkeshiensis this is not the case. They are arising on the bases not in common with those of trichoblasts. The writer also ascertained this important character in some French specimens, which are most closely related to this species in outward appearance also. (cf. p. 179 of this paper.) On the other hand, the new species resembles much ***P. Griffithiana*** HARVEY (Phyc. Brit., 1846-51. pl. 228) in external appearance, which was reported by DE TONI as a synonym of ***P. violacea.***

The other specimens from Kojima were found abundantly forming a tuft, associated with small *Corallina.* These plants are rather different from Akkeshi ones in the shape. The frond is 2.5-4.2 cm. high and arising from the basal disc. The disc shaped part sends out many rhizoids by means of which the tuft is fastened to the substratum. The frond densely and rather irregularly ramifies with distinct main axes. The branches sometimes are arranged alternately, sometimes vertically. The branchlets are penicillate, ovato-lanceolate in outline and sometimes decompositely branched in subcorymbose manner, sometimes long and distantly extended to virgate form. The articulations are gradually longer upwards and 0.3 times as long as diam. at the basal, 0.9 times at the middle, 1.3 times at the upper part of main axes. The cystocarps are ovate in shape. The trichoblasts develop very much near the apex of branch. The scar-cells can be seen clearly even in the lower part of the frond. In the ripe cystocarp many longitudinal series of cells which support the neighbouring peripheral cells are clearly seen from above (Fig. 24, G). They are arranged longitudinally at intervals in two files of peripheral cells apart.

In external appearance only this plant from Kojima resembles some

American specimens of *P. violacea* (for example Woods Hole, Herb. COLLINS, Distrib. from the Herb. New York Bot. Gard.), but it differs in the anatomical character as noted above.

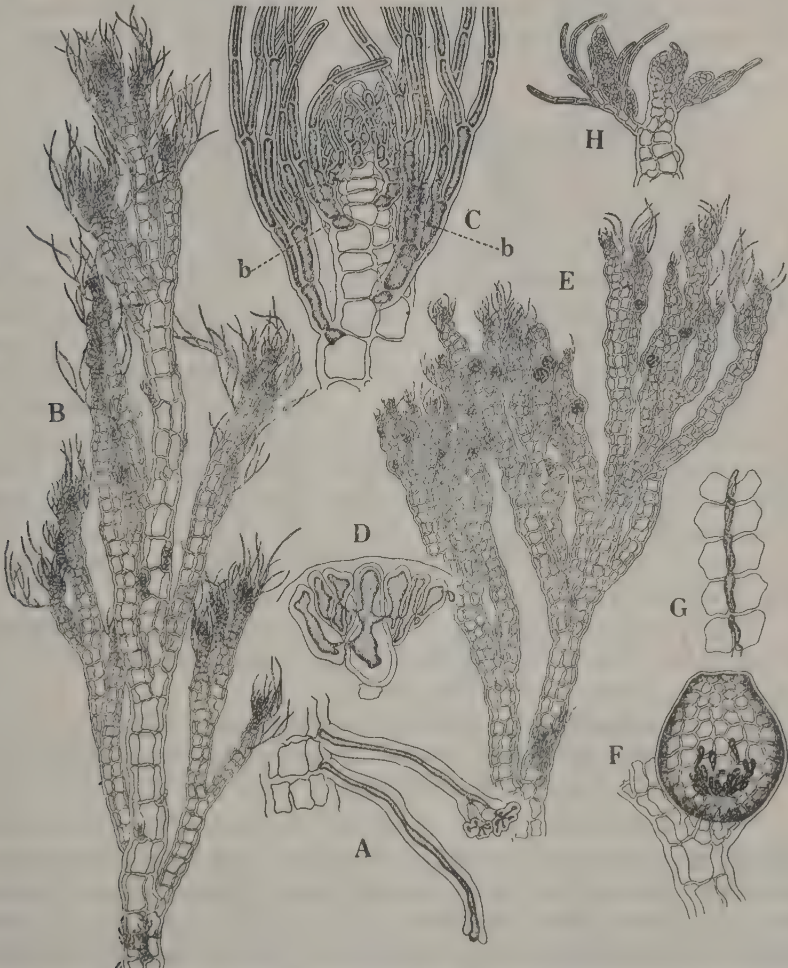



Fig. 24. *Polysiphonia akkeshiensis* SEGI. The specimen from Kojima. A. Rhizoids. ×60; B. Upper part of the branch. ×35; C. Tip of the branch showing "trichoblasts-unconnecting branches" (b). ×200; D. Part of the transverse section of the basal part of the frond ×60; E. Upper part of the tetrasporic branch. ×35; F. Cystocarp. ×60; G. Part of the pericarp with longitudinal series of cells supporting neighbouring peripheral cells. × 150; H. Antheridia. ×115.

Comparing with *P. novae-angliae* TAYLOR, this species can be distinguished from it by the difference of reproductive organs, articulation and substance viz. from the specimen of Akkeshi by not so elongate cystocarps, the peculiar antheridia with long sterile tips, longer articulations, rather rigid membranaceous substance and from the specimen of Kojima by the ovate cystocarps, shorter articulations, membranaceous substance and abundant trichoblasts.

## Polysiphonia abscissa HOOKER et HARVEY

Pl. IX, 4, and Text-fig. 25.

"Alg. Antarct. n. 38 (in Lond. Journ. IV) p. 266"; HARVEY, Flora Antarct. vol. 2 (1847) p. 480, pl. 183, fig. 2; Id., Ner. Austr. (1847) p. 43; Id., "Fl. Nov. Zel. II (1855) p. 277"; Id., "Fl. Tasm. (1860) p. 299"; KUETZING, Spec. Alg. (1849) p. 817; Id., Tab. Phyc. vol. 13 (1863) pl. 70, figs. a–d; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 974; ASKENASY, Alg. Forsch. "Gazelle" (1888) p. 49, pl. X, figs. 1–4; DE TONI, Syll. Alg. vol. 4 (1903) p. 879, vol. 6 (1924) p. 394; HOWE, Mar. Alg. of Peru (1914) p. 140; KYLIN et SKOTTSBERG, Subantarkt. u. Antarkt. Meeresalg. II. Rhodophyc. (1919) p. 53; DE TONI et FORTI, Alghe d'Australia, Tasmania Nouva Zelanda (1922) p. 38; OKAMURA, Nippon Kaisō Shi (1936) p. 827.

Syn. *P. sertularioides* (non J. AGARDH) NAGAI, Mar. Alg. Kurile Isl. II (1914) p. 226, pl. V, fig. 13.

Syn. *P. pacifica* HOLLENBERG, var. *disticha* HOLLENBERG, Polysiphonia on the Pac. Coast of North Amer. I, Oligosiphonia (1942) p. 778, figs. 4, 17.

Japanese name: *Sanbō-itogusa* (nov.).

Hab.: Bokke, Tōfutsu, Kunashiri Isl., Kurile Isls. (M. NAGAI).

Distri.: Cape Horn; New Zealand; Tasmania: Kerguelen Isl.; Falkland Isl.; Peru; North America (?).

Fronds forming tufts, loosely entangled with each other, elongate, fine, capillary, somewhat rigid, 4–6 cm. high, assurgent from decumbent base; filaments 130–150$\mu$ thick near the base, laxly branched, decomposito-subdichotomous, naked below, above alternately branched, with main axes indistinct, issuing numerous adventitious branchlets near the base, attached by scanty unicellular rhizoids; rhizoids a few scattered on the lower and upper parts of main axes, arising as outgrowths of the centre of the pericentral cells, not cut off by cross walls, one per segment, relatively robust compared with plant, about 375$\mu$ long, 22–30$\mu$ thick, sometimes provided with a discoid hapter at the end; branches exogenously arising in 4–8 segments apart, alternate, lateral,

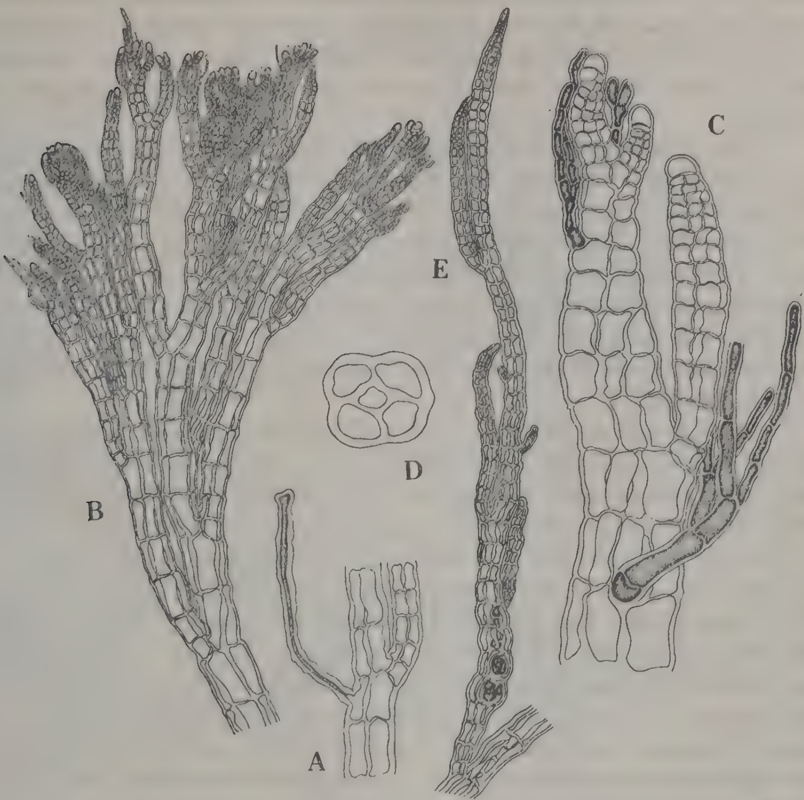



Fig. 25. *Polysiphonia abscissa* HOOKER et HARVEY. A. Rhizoid. ×115; B. Upper part of the branch. ×115; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond. ×200; E. Branchlet with tetraspores. ×60.

the lowest longest, the rest gradually shorter above, pinnately divided, plumose at the apex; branchlets inferior patent and distant, superior erect and adproximato-corymbose; penultimate branchlets virgate, slender, elongate, often recurved, obtuse at the tip; trichoblasts a few arising on the upper part of branchlets, at irregular intervals, mostly 2–3 segments apart, in a left hand spiral with ¼ divergence to the branchlets, simple or once forked, about 135–255$\mu$ long, rather persistent, leaving no scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, about 1.7–2.5 times as long as diam. at the basal, about 3–4 times at the middle, 1–2 times at the

upper part of main axes; siphons 4 in number; tetrasporangia several arranged in a longitudinal series in the lower parts of branchlets, continuous, prominent, elliptical, $45 \times 75\mu$, indistinct in dividing manner. Colour dark purplish or redish brown. Specimens not or imperfectly adhering to paper in drying.

The present species is characterized by possessing adproximato-corymbose branchlets which are crowded and level-topped, as if cut off at the upper part of them. A projecting sterile axial cell can be observed clearly on the tip of branchlets. The trichoblasts arise vigorously near the tip of branches as shown in Figure 25, C, and occur 2–3 segments apart mostly with $\frac{1}{4}$ divergence to the branchlets, not on each segment. ASKENASY also reported on this point that "etwa jedes dritte bis sechste Glied ein solches Haar Trägt." In addition, he followed the formation of cystocarp with figures, although the writer has not observed it.

This species accords rather well with *P. abscissa* HOOKER et HARVEY in the descriptions and figures given by HARVEY and foreign specimens (Herb. R. M. LAING, Lyttelton, New Zealand, Det. By COTTON; Herb. Univ. Calif. No. 197773, New York. Bot. Gard., Peru, collected by ROBERT E. COKER).

NAGAI has identified this alga with *P. sertularioides* (GRATELOUP) J. Agardh in his paper (l. c.). Judging from the original and other descriptions of *P. sertularioides* and comparing the photograph (Herb. Univ. Calif. No. 141488, det. L. KOLDERUP ROSENVINGE, leg. GALLIA; Antibes, I, 1885) and the foreign specimen (e.g. Herb. Univ. Calif. No. 492699, FELDMANN, Villefranche, Apr. 1928) of it, however, this plant differs much from it in having the "abscissa" branchlet which is striking feature of this species for separating it from the allied ones. Furthermore, in the mode of branching in origin in relation to trichoblasts it is quite different from *P. sertularioides* (cf. p. 194 of this paper). The Kunashiri plant is to be identified with *P. abscissa* evidently instead of *P. sertularioides.*

On the other hand this species seems to be closely allied to *P. pacifica* var. *disticha* HOLLENBERG (l. c.) in general habit and also to *P. pacifica* HOLLENBERG in the shape of branch tip (l. c. fig. 3). The latter species was recently separated from *P. urceolata* by HOLLENBERG, according to the scantiness of the trichoblasts and scar-cells. As for the trichoblast-non-bearing species, however, the writer keeps it with some doubt under the separated species. In the writer's opinion, the trichoblasts are rather variable in their occurence.

## Polysiphonia urceolata (DILLWYN) GREVILLE

Pl. X–XI, 1, and Text-figs. 26–27.

"Fl. Edin. (1824) p. 309"; HARVEY, Phyc. Brit. (1846–51) pl. 167; Id., Man. (1849) p. 82; Id., Ner. Bor. Amer. (1853) p. 32; KUETZING, Spec. Alg. (1849) p. 824; Id., Tab. Phyc. vol. 13 (1863) pl. 92, figs. a–b; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 970; Id., Florid. Morphol. (1879) pl. 33, fig. 15; FARLOW, Mar. Alg. New Eng. (1881) p. 170; ARDISSONE, Phyc. Mediter. vol. I (1883) p. 397; KJELLMAN, Alg. Arc. Sea (1883) p. 118; ROSENVINGE, Bidrag till Polysiphonia's Morfologi, Bot Tidskr. 14 (1884) p. 24, fig. 32; Id., Mar. Alg. Denmark III (1923–24) p. 406, figs. 341–349; HAUCK, Meeresalg. (1885) p. 221; BUFFHAM, On antheridia (1893) p. 298; SCHMITS u. FALKENBERG, in Engler u. Prantl's Nat. Pflanzenfam. (1897) I. 2, Rhodomelac. p. 439, fig. 246; FALKENBERG, Rhodomelac. (1901) p. 150; DE TONI, Syll, Alg. vol. 4 (1903) p. 875, vol. 6 (1924) p. 393; KYLIN, Algenfl. schwed. Westkueste (1907) p. 139; Id., Rhodo. schwed. Westkueste (1944) p. 82, pl. 25, figs. 73–74; YENDO, Notes on Alg. New to Japan IV (Bot. Mag. Tōkyō, vol, 30, 1916) p. 60; BATTEN, The Genus Polysiphonia (in Journ, Linn. Soc. Bot. vol. 46, 1923) p. 288, pl. 22, fig. 3, 23, pl. 23, figs. 24–25; YAMADA, Mar. Alg. Mutsu Bay, II (1928) p. 522; LAKOWITZ, Algenfl. gesamten Ostsee (1929) p. 338, fig. 456; INAGAKI, Osyorowan no Kaisankosōrui (1933) p. 62. OKAMURA, Nippon Kaisō Shi (1936) p. 824, fig. 388; TAYLOR, Mar. Alg. Northeast. coast of North Amer. (1937) p. 368; YAMADA and TANAKA, Akkeshi (1944) p. 75.

Syn. *Conferva urceolata* DILLWYN, "Brit. Conf. (1809) p. 82".

Japanese name: *Syōzyō kenori.*

Hab.: Asamushi, Mutsu Prov. (Y. YAMADA); Rausu, Muroran, Hanasaki (H. HIROSE), Shiretoko peninsula (Y. YAMADA), Akkeshi (T. TANAKA), Hakodate (K. YENDO, J. TOKIDA) and Esashi (Y. YAMADA, Y. NAKAMURA, A. KARAKAWA), Hokkaidō; Shikotan Isl., Kurile Isls, (S. KAWABATA); Sakaehama, Saghalien (INOUE); Akashi, Harima Prov.; Shinmaiko and Ikawatsu, Owari Prov.; Shirisawabe, Mutsu Prov. (K. YENDO).

Distri.: Cosmopolitan.

Fronds caespitose, densely tufted, loosely entangled with each other, slender, elongate, erect, setaceous, rather rigid, 10–13.5 cm. high arising from rather matted bases; filaments about 270$\mu$ thick near the base, slightly prominent at the nodes in the lower, generally without leading stems, branched in dichotomo-pinnate manner, attached by the unicellular rhizoids at the base; rhizoids arising as outgrowths of the pericentral cells, often in the axils of branches, not (?) cut off by cross walls, 255–450$\mu$ long, 45–52$\mu$ thick, without a

discoid hapter at the end; branches arising exogenously at intervals 3–4 segments apart, alternate, flexuose, below rather sparse and with short virgate branchlets, above densely branched in pinnate manner and often with very




Fig. 26. *Polysiphonia urceolata* (DILLWYN) GREVILLE. A. Upper part of the frond. ×35. f. *typica* KJELLMAN. The specimen from Asamushi; B. Upper part of the frond. ×35. f. *lepadicola* (LYNGBYE) SEGI. The specimen from Hanasaki; C. Upper part of the frond. ×35. f. *patens* (DILLWYN) HARVEY. The specimen from Rausu; D. Transverse section of the basal part of the frond. ×115. f. *typica* KJELLMAN; E. Cystocarp. ×60.

slender, rhizoids; branchlets issuing in every direction, (2)-3-(4) segments apart, alternate, usually straight, rather patent downwards, but gradually narrow axils upwards, provided with virgate, straight, sharply pointed ultimate branchlets; trichoblasts unknown; articulations pellucid, ecorticated, about 0.4 times as long as diam. at the basal, about 4.6 times at the middle, almost as long as diam. at the upper part of erect filaments; siphons 4 in number; tetrasporangia a few or several seriate in the middle parts of ultimate branchlets, sometimes small, globose, about $30\mu$ diam., sometimes very large, extremely prominent, about $75\mu$ diam., divided in tripartite manner; cystocarps numerously scattered on the middle parts of branchlets, urceolate with protuberant neck and cleft, about $300\times450\mu$, shortly pedicellate. Colour dark brown. Specimens imperfectly adhearing to paper in drying.

The present species is divided into three forms as follows:

f. **typica** KJELLMAN

Alg. Arc. Sea (1883) p. 118; HARVEY, Phyc. Brit. (1846-51) pl. 167; Phyc. Bor. Amer. Fas. 15 (1900) No. 748; KYLIN, Rhodo. schwed. Westkueste (1944) p. 82, pl. 25, fig. 73.

Syn. *P. pungens* HOLLENBERG, Polysiphonia on the Pac. Coast of North Amer. I, Oligosiphonia (1942) p. 774, figs. 1, 10.

Above mentioned diagnosis is based on Asamushi specimens which were identified with this species by YAMADA, comparing with the authentic specimen in the Agardhian Herbarium at Lund. The present specimens also agree well with the photograph of *P. urceolata* f. *typica* given by KYLIN (l. c. 1944) and present such forms as noted by him "Thallus 4-10 cm. hoch, dichte Rasen bildend." This plant is most commonly distributed from the cooler to the warmer temperate waters in Japan.

The specimen from Sakaehama which assumes dark purplish red, not brownish colour agrees quite well with American one of this species (Phyc. Bor. Amer., Fas. 15, No. 748, c).

This species is rather variable in the aspect. In external appearance the plant belonging to the f. *typica*, often resembles much *P. senticulosa*. But the former can be distinguished from the latter by the anatomical characteristic as mentioned in p. 249 of this paper. The specimens from Akashi and Ikawatsu resemble much *P. senticulosa* in external appearance, but they seem to differ in the origin of branches. Perhaps they seem to be identified with *P. urceolata*. In Akashi specimens collected in February the robust, long trichoblasts which are thrice forked and $5750\mu$ long can be observed distinctly. They are produced vigorously on the indeterminate branchlets only and in a left hand spiral with ¼ divergence to the branchlets, two segments apart (not on each segment). As for the trichoblasts, ROSENVINGE, KYLIN and FALKEN-

BERG noted as follows. ROSENVINGE reported that they are wanting in autumn and winter, but present in March-August (Mar. Alg. Denmark III, 1923–24, p. 408), and KYLIN noted that they are scantily in summer, but abundant in spring (Ueber Anatomie und Fruchtentwicklung bei P. urceolata, 1937, p. 2), although FALKENBERG stated the entire absence of them (Rhodomelac. 1901, p. 151).

HOLLENBERG established a new species *P. pungens* HOLLENBERG (l. c.) characterized by the presence of virgate, sharply pointed, ultimate branchlets. In the writer's opinion, however, such branchlets can be seen also in other species, as in *P. urceolata* or *P. senticulosa* in most cases. So it is rather difficult to distinguish it from them by this characteristic. Therefore *P. pungens* seems to be identical with *P. urceolata*. The specimen from Hakodate collected by J. TOKIDA and the photograph (as *P. urceolata*, Herb. Univ. Calif. No. 95299, San Francisco, Y. W. LICHTENTHALER, 1886) seem to be the same as HOLLENBERG's species.

f. **lepadicola** (LYNGBYE) SEGI comb. nov.

Syn. *Hutchinsia lepadicola* LYNGBYE, Hydro. Dan. (1819) p. 113, pl. 35, C; C. AGARDH, Syst. Alg. (1824) p. 148; Id., Spec. Alg. vol. 2 (1828) p. 107.

Syn. *P. lepadicola* (LYNGBYE) KUETZING, Spec. Alg. (1849) p. 807; Id., Tab. Phyc. vol. 13 (1863) pl. 37, figs. d–e; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 945; DE TONI, Syll. Alg. vol. 4 (1903) p. 873; ROSENVINGE, Mar. Alg. Denmark III (1923–24) p. 411.

There is to be found in Rausu materials a minute species which is identical with such a plant as figured by KUETZING in Tab. Phyc. (l. c.) under the name of *P. lepadicola*. In the present species, however, the frond is more densely and pinnately ramified at the apex of branchlets than that of the KUETZING's specimen. It is a very fine, only 1.3 cm. high and usually composed of 4 siphons, but sometimes 5 ones at the base. Though DE TONI described *P. lepadicola* (LYNGBYE) KUETZING as a distinct species in Syll. Alg. (l. c.), ROSENVINGE considered it as a form of this species and reported that "Small, poorly developed specimens consisting principally of creeping filaments have been described by LYNGBYE as a particular species, *Hutchinsia lepadicola* LYNGB. (*Polys. lepadicola* Ag.)" in Denmark (l. c. p. 411). Our plant also is tentatively to be referred to the present species until more abundant material can be obtained.

The specimens from Hanasaki and Akkeshi assuming dark or redish brown in colour perhaps belong to this form. But the ultimate branchlets are usually simple and not so ramified as those of Rausu plant.

f. **patens** (DILLWYN) HARVEY

Ner. Bor. Amer. (1853) p. 32; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 971;

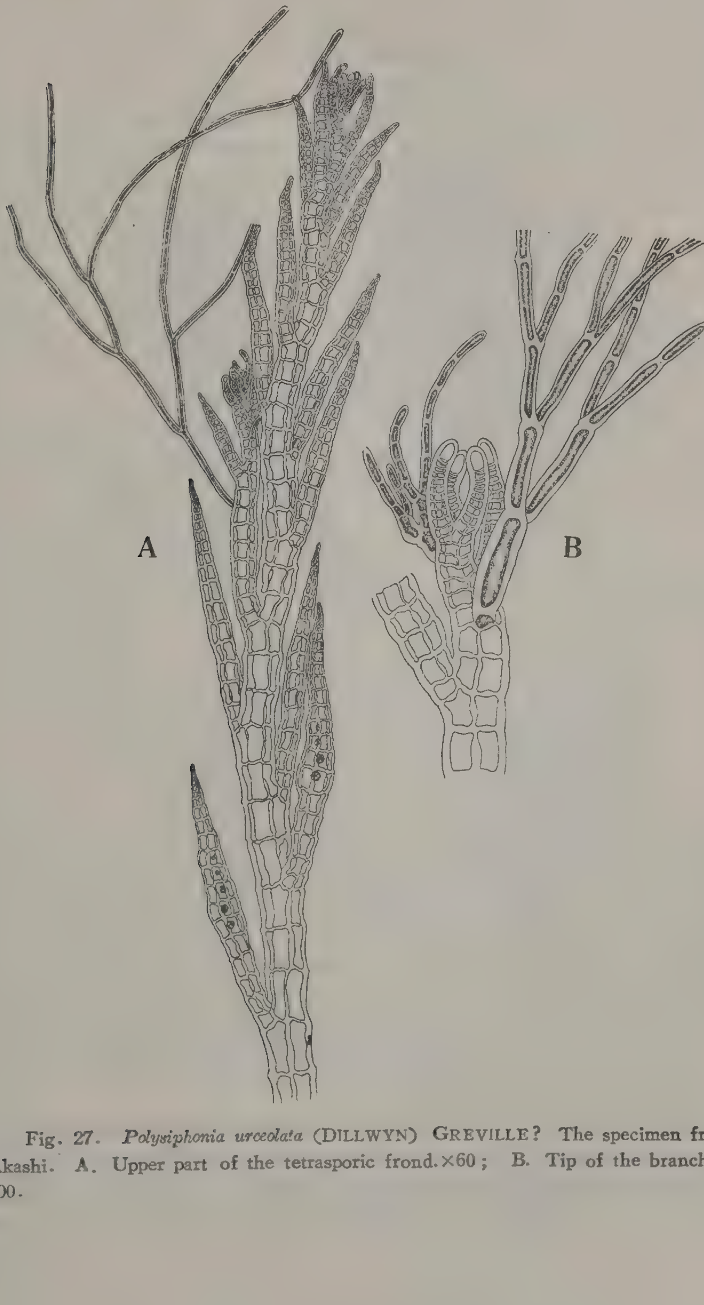



Fig. 27. *Polysiphonia urceolata* (DILLWYN) GREVILLE? The specimen from Akashi. A. Upper part of the tetrasporic frond. ×60; B. Tip of the branch. × 200.

FARLOW, Mar. Alg. New Eng. (1881) p. 170; Phyc. Bor. Amer. Fas. 20 (1902) No. 997.

Syn. *P. senticulosa* (non HARVEY) KAWABATA, List. Mar. Alg. Shikotan (1936) p. 211.

The Rausu plant belonging to this form was found growing on the frond of *Rhodoglossum pulchrum* (POST. et RUPR.) SETCHELL et GARDNER tuftly. The frond is rather rigid in the substance and provided with a more or less evident leading stem. It is branched in dichotomous manner, having long, subsimple branches which are further ramified in lateral, multified branchlets. The branchlets, especially the lower ones, are extremely patent and strongly recurved backwards as shown in Figure 26, C. The articulations are almost equal to diam. or slightly longer than it. It is distributed in the cooler temperate waters, as in Hokkaidō.

Being compared with American specimen (Phyc. Bor. Amer. 1. c.), the present species agrees well with it in general, except only darker colour.

KYLIN's photograph under the name of *P. urceolata* f. *roseola* (1. c. 1944, pl. 25, fig. 74) shows much resemblance to this form.

KAWABATA identified the specimens from Shikotan Isl. attaining often to more than 25 cm. in height with *P. senticulosa* in his list (1. c.). His specimens, however, differ from it in every respects. They are to be identified with the present form evidently.

## Polysiphonia Morrowii HARVEY

Pl. XI, 2, and Text-fig. 28.

In "GRAY's list of Plants collected in Japan (1856) p. 331"; KUETZING, Tab. Phyc. vol. 14 (1864) p. 17, pl. 47, figs. a-c; DE TONI, "Phyc. Jap. (1895) p. 33"; Id, Syll. Alg. vol. 4 (1903) p. 960, vol. 6 (1924) p. 393; OKAMURA, Icon. Japan. Alg. vol. 3 (1914) p. 104, pl. 127, figs. 1-8; Id., Nippon Kaisō Shi (1936) p. 826, fig. 390, 1–5; INAGAKI, Osyorowan no Kaisankōsōrui (1933) p 59; TSENG and LI, "Some Mar. Alg. fr. Tsingtao and Chefoo, p. 223"; NAGAI, Mar. Alg. Kurile Isl. II (1941) p. 226; YAMADA and TANAKA, Akkeshi (1944) p. 75.

Syn. *Orcasia Morrowii* (HARVEY) KYLIN, Calif. Rhodo. (1941) p. 35.

Japanese name: *Moro-itogusa.*

Hab.: Yunohama, Okujiri Isl. (Y. HASEGAWA), Osyoro, Muroran (Y. NAKAMURA, A. KARAKAWA), Esashi (Y. YAMADA, Y. NAKAMURA, A. KARAKAWA, Y. HASEGAWA), Shioya (Y. NAKAMURA), Abashiri (C. MURAOKA), Yamasedomari (Y. YAMADA, J. TOKIDA), Rishiri

Isl. (FAURIE, J. TOKIDA), Oshima Motoyoshi (K. YENDO), Zenibako (J. TOKIDA, H. HIROSE), Tachimachi-misaki (J. TOKIDA), Nemuro (H. HIROSE), Rumoe (H. HIROSE), Samani and Hakodate (K. OKAMURA), Hokkaidō; Kotan, Kaibatō Isl. (J. TOKIDA)

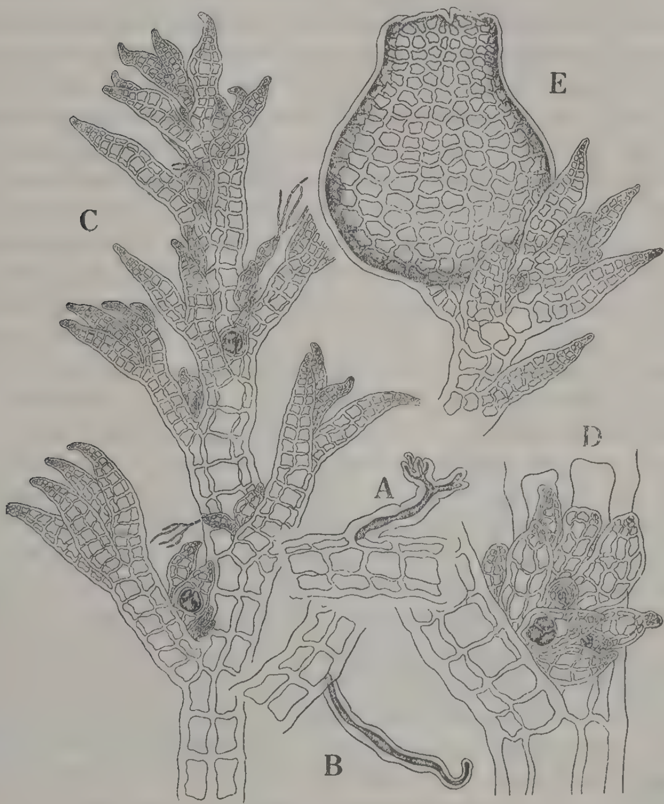



Fig. 28. *Polysiphonia Morrowii* HARVEY. A–B. Rhizoids. ×60; C. Upper part of the tetrasporic branch. ×35; D. Stichidia. ×60; E. Cystocarp. ×60.

and Rakuma, Chinehira, Saghalien (J. TOKIDA); Kunashiri Isl., Kurile Isls. (M. NAGAI); Fukaura (C. KANDA), Asamushi and Shimofuro (K. YENDO), Mutsu Prov.; Onagawa, Rikuzen Prov. (S. INOH); Syōbuta, Echigo Prov. (Mrs. WAINWRIGHT): Hakuhi,

Noto Prov. (K. OKAMURA); Enoshima, Sagami Prov. (K. OKAMURA); Japan (FARLOW).

Distri.: Northern parts of Japan; China.

Fronds densely tufted, slender, very elongate, rather rigid and coarse, setaceous, 11–15 cm. high; filaments about 450$\mu$ thick near the base, often entangled with each other, alternately branched in decompound pinnate manner, issuing some, pinnate, hooked, adventitious branchlets, attached by unicellular rhizoids naer the base; rhizoids irregularly arising as outgrowths of the corner of the pericentral cells, not cut off by cross walls, sometimes short, about 525$\mu$ long, 45$\mu$ thick, sometimes very elongate, simple or divided near the end, often provided with a dilated hapter at the end; branches exogenously arising in 4–5 segments apart, elongated, flexuose, the primary ones below naked or provided with a few hooked simple or divided branchlets, above issuing pinnate branchlets at 3–4 segments apart; branchlets linear in outline, patent, densely pinnulated on all sides; penultimate branchlets short, erect or erect-patent, often recurved, simple below, above multified in subulate, sharply pointed ultimate ones; trichoblasts a few arising near the apex of stichidial branchlets, 1–2–3 forked, 500–600$\mu$ long in the longest, deciduous, leaving no scar-cells; branches not connected with trichoblasts in origin (?); articulations opake, ecorticated, 0.3 times as long as diam. at the basal, 4.3 times at the middle, 1.5 times at the upper part of main axes (a little longer at the brahchlets, 0.5 times at the penultimate ones); siphons 4 in number; tetrasporangia formed in fusiform stichidial branchlets densely arising in clusters in the axils of ramuli, 3–4 arranged in a longitudinal row, prominent large, globose, about 75$\mu$ diam. divided in tripartite manner; cystocarps borne on the upper branchlets, urceolate, 525–570$\times$657–705$\mu$, slightly crenulated at the margin, shortly pedicellate, with a neck and wide ostiole at the apex. Colour dark brownish black (almost black). Specimens not adhering to paper in drying.

The above mentioned diagnosis is based on the materials from Yunohama, Okujiri Isl. The materials examined seem to be distributed very commonly in Hokkaidō and the northern parts of Honsyū, Japan. This species is very elongated, rigid and coarse in the substance, usually blackish in the colour and not adhering to paper in drying, as noted above in the diagnosis. The present plant contains two forms of the cystocarp. The one has broad neck and cleft as described and figured by OKAMURA and the other is narrow as shown in Figure 28, E.

Being compared with OKAMURA's numerous specimens (Herb. OKAMURA, Nofu, Ōme-gawa, Naoetsu, Echigo Prov. and Herb. Mus. Paris, n. 9732, Rishiri Isl., Hokkaidō, coll. FAURIE, leg. HARIOT, det. OKAMURA), the present alga agrees well with them in general. Excellent illustrations of the Japanese specimens

are to be found in OKAMURA's Icon. (l. c.).

The present species is frequently close to *P. senticulosa* HARVEY in general appearance and often it is not easy to delimit clearly these two species as the distinct ones. As noted by OKAMURA, however, it can be distinguished from the latter species in the peculiar stichidia. In this species the stichidia grow tuftly in the axils of branchlets as shown in Figure 28, D, while in *P. senticulosa* this is not the case. A few trichoblasts occur near the apex of ultimate branchlets of the stichidia having endogenous origin. On the point of insertion of them only the basal cell can be seen clearly, but in the other place the scar-cell is not observed at all.

KYLIN reported the presence of endogenous new "Langtriebe" in this species as well as *P. senticulosa* (l. c.), although the writer has not been able to observe it in the present materials. According to this characteristic, he put this species into his new genus, *Orcasia*. For the present, however, the writer interpreted the genus *Polysiphonia* in a broader sense and classified even this species into *Polysiphonia* as hitherto described.

## Polysiphonia senticulosa HARVEY

Pl. XII, and Text-figs. 29–30.

"Notice of a collection of Algae made on the North West Coast of North America, chiefly at Vancouver Islands, by DAVID LYALL. (Journ. Linn. Soc. Bot. vol. 6, London, 1862) p. 169"; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 974; SETCHELL and GARDNER, Alg. of Northwest. Amer. (1903) p. 327; DE TONI, Syll. Alg. vol. 4 (1903) p. 879, vol. 6 (1924) p. 394; YENDO, Notes on Alg. New to Japan, II (Bot. Mag. Tōkyō, vol. 28, 1914) p. 276; INAGAKI, Osyoro wan no Kaisankōsōrui (1933) p. 60, fig. 25; OKAMURA, Nippon Kaisō Shi (1936) p. 825; NAGAI, Mar. Alg. Kurile isl. II (1941) p. 226.

Syn. *Orcasia senticulosa* (HARVEY) KYLIN, Calif. Rhodo. (1941) p. 35, fig. 7, C–F.

Japanese name: *Mutsu-itogusa* (nov.).

Hab.: Asamushi, Mutsu prov. (Y. YAMADA); Samukawa, near Hakodate, Hokkaidō (T. MORITAKE).

Distri.: Vancouver Isl., Orcas Isl., North America.

Fronds densely tufted, often entangled with each other, erect, slender, elongate, setaceous, coarse, rather rigid, about 17–23 cm. high, arising from matted base; filaments about 480$\mu$ thick near the base, with no distinct main axes, not prominent at the nodes, branched in dichotomo-pinnate manner,

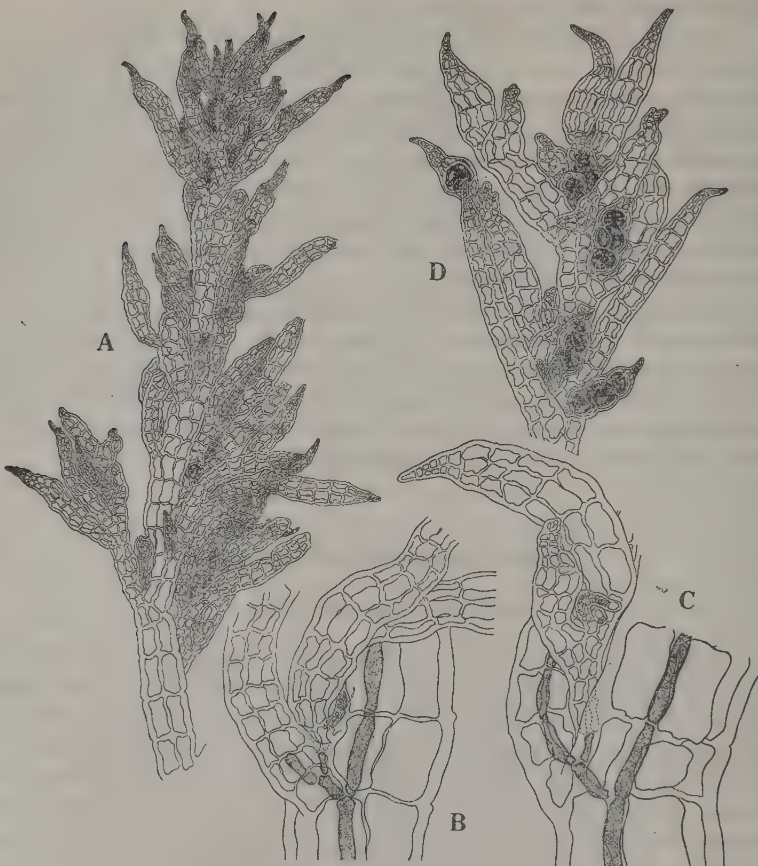



Fig. 29. *Polysiphonia senticulosa* HARVEY. A. Upper part of the tetrasporic branch. × 35; B–C. New endogenous "Langtriebe" arising in the axil between "Kurztriebe" and "Langtriebe". ×115; D. Stichidia. ×60.

attached by the unicellular rhizoids at the base; rhizoids arising as outgrowths of the pericentral cells at the basal filament, not cut off by cross walls, 525–750$\mu$ long, 60–105$\mu$ thick, provided with a dilated hapter at the end; branches exogenously arising in 4 segments apart, alternate, flexuose, inferior nude or sometimes provided with spine-formed, short branchlets, superior furnished with linear, long ones in pinnate manner; new indeterminate branches arising endogenously in the axils between determinate branches and indeterminate ones;

branchlets arising in 3–4 segments apart, slightly zigzag in form, alternate, patent or almost with right angles, pinnately divided; pinnate branchlets arising in 2 segments apart, simple, short, subulate, erecto-patent, below nude or sometimes issuing long straight, ultimate branchlets, above densely ramified in virgate, sharply pointed ultimate branchlets; trichoblasts unknown; articulations pellucid, ecorticated, about 1.3 times as long as diam. near the basal, about 7 times at the middle, about 1.4 times at the upper part of erect filaments; siphons 4 in number; tetrasporangia a few formed on the short, simple stichidial branchlets, prominent, verrucose, large, globose, 60–75$\mu$, divided in tripartite manner. Colour redish dark brown. Specimens not or imperfectly adhering to paper in drying.

The present specimens from Asamushi were identified with *P. senticulosa* HARVEY by YAMADA, after examing the authentic specimen in the Agardhian Herbarium at Lund. Above mentioned diagnosis bases on it.

This species is very confused and troublesome one in this genus. Hitherto it is frequently mixed with *P. urceolata* or *P. Morrowii*, which is too difficult to be distinguished from them by the external appearance only. At present it is a good chance to solve the confusion. As noted by *Kylin* (l. c.), in the present species the new "Langtriebe" occur in the axil between "Kurztriebe" and "Langtriebe" and arise endogenously from the central axial cell of the older node with developed pericentral cells. Commonly it is arising on the lowermost articulation of polysiphonous "Kurztriebe." Thus the writer was fortunately to ascertain this delicate, important characteristic and figured it clearly (Fig. 29, B, C). From *P. urceolata* the difference in origin of branches offers important criterion for discrimination. In *P. urceolata* the lateral branches arise exogenously from the articulation which is yet issuing no pericentral cell, while in *P. senticulosa* this is not the case as noted above. From *P. Morrowii* the differences of the stichidia will easily suffice to differenciate it. In *P. Morrowii* the stichidia are formed tuftly in the axils of branches, while in *P. senticulosa* they occur scatteringly near the axils of branches, never being tufty in most cases. The tetraspores are borne usually on the stichidia, and rarely on the normal ultimate branchlets. Furthermore, the frond is commonly brown or redish brown in colour and not so rigid as that of *P. Morrowii* in the substance.

In external appearance, the materials from Esashi much resemble the photograph of the type specimen of this species at Dublin and that of KYLIN's species (l. c. pl. 11, fig. 33, as *Orcasia senticulosa* (HARVEY) KYLIN). In anatomical character, however, the new "Langtriebe" scarcely can be seen, as far as could be observed. It may better be placed with *P. urceolata*.

There is a male plant referred to *P. senticulosa* or *P. urceolata*. It was

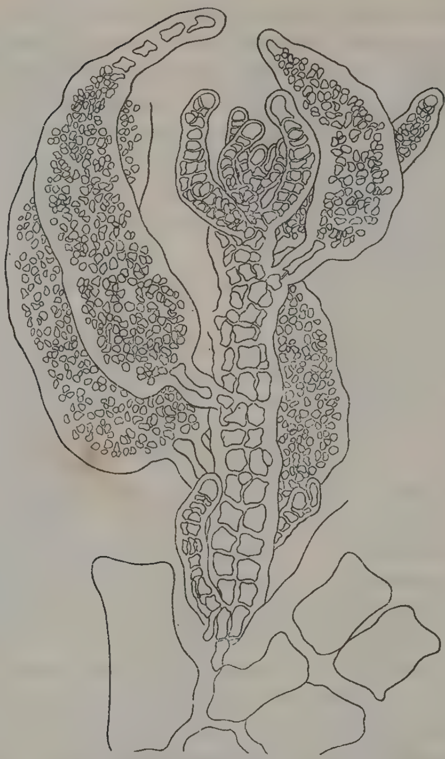


Fig. 30. *Polysiphonia senticulosa* HARVEY (?). Antheridia. ×350.

collected by T. MORITAKE at Samukawa, near Hakodate, Hokkaidō. The antheridia are aggregated on the upper part of special branchlets which arise endogencusly on the fork of branches and formed near the basal part of simple trichoblasts themselves. They are cylindrical in shape, attaining to 60×195$\mu$ in size. At the lower part they are supported by two-celled stalks and at the upper terminated by a short (1-celled) or long (4-celled) sterile tips as shown in Figure 30. In this male plant, however, the writer has not been able to see any endogenous "Langtriebe." At present it is rather difficult to determinate it, owing to scanty material. On the other hand, this male plant seems to be allied to *P. Morrowii* in some degree. From it, however, the redish-brown and rather soft frond of the former will serve to distinguish it.

Basing on this species, KYLIN established a new genus *Orcasia* (1. c.), according to the presence of new endogenous "Langtriebe". For the present, however, the writer interpreted the genus *Polysiphonia* in a broader sense and classified even this species into *Polysiphonia* as hitherto described. But it is not strange, if one may put this species in other genus, *Orcasia*.

## Polysiphonia forcipata HARVEY

Pl. XIII, 1, and Text-fig. 31.

"Mar. Bot. of West Austr. p. 541"; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 1024; KUETZING, Tab. Phyc. vol. 14 (1864) p. 15, pl. 44, figs. a–d; DE TONI, Syll. Alg. vol. 4 (1903) p. 920.

Syn. *P. forfex* HARVEY, Phyc. Austr. vol. 2 (1859) pl. 96.

Syn. *P. fragilis* SURINGAR, Alg. Japon. (1870) p. 37, pl. 25, B. figs. 1–4; DE TONI, Syll. Alg. vol. 4 (1903) p. 921; OKAMURA, Icon. Japan. Alg. vol. 6 (1929) pl. 255, figs. 1–15; Id., Nippon Kaisō Shi (1936) p. 834, fig. 391.

Japanese name: *Kuro-itogusa.*

Hab.: Muroran, Hokkaidō (A. KARAKAWA); Enoshima, Sagami Prov. (K. OKAMURA); Susaki, Izu Prov. (S. ARASAKI).

Distri.: Australia; China.

Fronds densely caespitose, forming subglobose tufts, slender, coarse, rather fragile, 3.3–4 cm. high, assurgent from basal decumbent portions, erect filaments about 300–330$\mu$ thick near the base, with no percurrent axes, cylindrical, slightly attenuated upwards, repeatedly branched in regular dichotomo-alternate manner from the base, attached by unicellular rhizoids near the base; rhizoids irregularly arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, sometimes short, robust, about 300$\mu$ long, 60$\mu$, thick, provided with a dilated hapter at the end, sometimes very long, slender, about 2550$\mu$ long, about 45$\mu$ thick; branches exogenously arising with rather acute angles, below nude or sparsely branched, above densely branched in subfastigiato-corymbose manner, become entangled to each other by emitting rhizoids from lower or upper portions; ultimate branchlets virgate, elongate, flexuose, 60–75$\mu$ thick in the middle part, slightly attenuated at the base, rather acute and forcipate at the apices; trichoblasts moderately issued near the apex of ultimate branchlets, arising one per segment in a left hand spiral with $\frac{1}{5}$ ($\frac{1}{4}$) divergence, usually simple, 90$\mu$ long, rather persistent, often leaving inconspicuous scar-cells; branches not connected with trichoblasts in origin; articulations pellucid, ecorticated, rather short, about 0.5 times as long as diam. at the

basal and middle, about 0.7 times at the upper part of erect filaments; siphons 5 in number; tetrasporangia numerous, spirally arranged on the upper parts of branchlets, prominent, continuous or interrupted, verrucose, globose, about 90–105$\mu$ diam., tripartitely divided; cystocarps and antheridia unknown. Colour brownish black. Specimens imperfectly or not adhering to paper in drying.

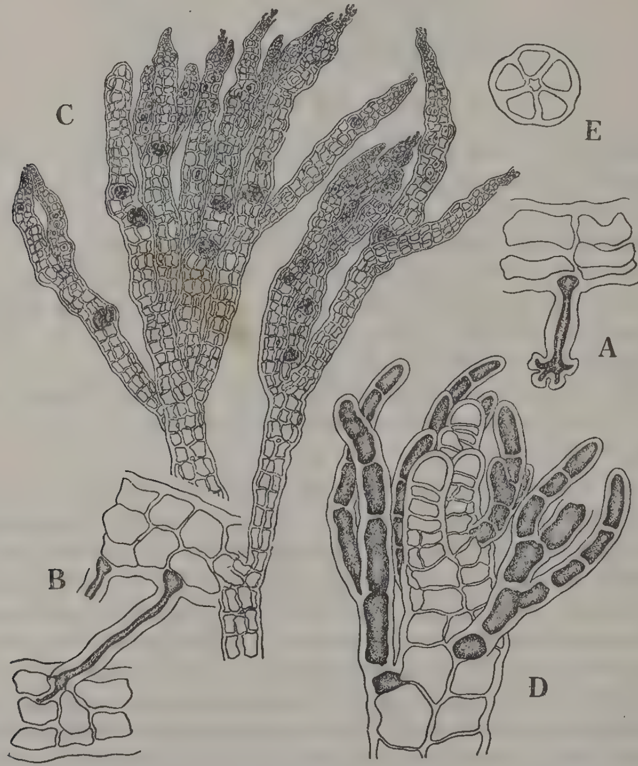



Fig. 31. *Polysiphonia forcipata* HARVEY. A. Rhizoid. ×60. B. Rhizoid, connecting with each filament near the base. ×60. C. Upper part of the tetrasporic branch. ×35. D. Tip of the branch. ×350. E. Transverse section of the basal part of the frond. ×115.

The present species varies considerably in the form and ramification of the frond. In Muroran specimens the frond is very small and presents such a form as mentioned above in the diagnosis. The branch is connected with each other by rhizoids from lower or upper portions (Fig. 31, B). In Enoshima ones

it is 50–70 cm. in height and rather irregularly branched. The branch is not so forcipate at the apex as Muroran ones. The ramification is rather regularly dichotomous The branch is more or less forcipate at the apex.

The divergence of the trichoblasts in the spiral is generally considered as $\frac{1}{5}$, bearing a relation to the number of pericentral cells. Especially in the apex of branch, however, it often bears $\frac{1}{4}$, as far as could be observed.

As pointed out by De Toni, at present the writer thinks it is more reasonable to refer the present specimens to *P. forcipata* Harvey than to identify them with *P. fragilis* Suringar. But Okamura reported that "De Toni considers 'haec species japonica cum *Polysiphonia forcipata* Harv. quadrare videtur,' Syll. Alg. IV, p. 921; which is quite out of place. A distinct Species." In the present materials the branch is more or less forcipate at the apex as may be detected in *P. forcipata.* Consequently it is impossible to clearly delimit these two species in writer's examination, according to the description (De Toni 1. c.), figures (Kuetzing 1. c.) and the foreign specimens (Herb. Lenormand, Pyrano) of *P. forcipata. P. fragilis* seems to be graded into some forms of *P. forcipata.* In foreign specimens, however, the writer has not been able to examine any origin of branches in relation to the trichoblasts regretfully.

## **Polysiphonia Richardsoni** Hooker

Pl. XIII, 2.

"Br. Fl. vol. 2, p. 33"; Harvey, Man. (1849) p. 90; Id., Phyc. Brit. (1846–51) pl. 10; J. Agardh, Spec. Alg. vol. 2 (1863) p. 1033; Kuetzing, Tab. Phyc, vol. 13 (1863) pl. 83, figs. a–e; Johnst. & Croall, "Brit. Sea Weeds 1, p. 31, figs. 1–5"; De Toni, Syll. Alg. vol. 4 (1903) p. 920, vol. 6 (1924) p. 398; Batten, The Genus Polysiphonia (in Journ. Linn. Soc. Bot. vol. 46, 1923) p. 294, pl. 24, fig. 50.

Syn. *P. Marchantae* Setchell et Gardner, New Mar. Alg. Gulf of Calif. (1924) p. 768, pl. 49, a.

Japanese name: *Motsure-itogusa* (nov.).

Hab.: Shinmaiko, Owari Prov.

Distri.: The coast of occidental Scotland; California.

Fronds caespitose, elongate, slender, setaceous, rather rigid, 4–5.8 cm. high; filaments 375–525$\mu$ thick near the base, with main axes indistinct, much branched and zigzag in form, provided with spinulose adventitious branchlets; branches the lowest issuing in every directions at almost right angles, the rest divaricate, often alternate, elongate, flexuose; branchlets distantly and subdichotomously arising in patent axils, like the branches, slender, strict, bearing

a few mostly simple, erect, subulate, ultimate branchlets; trichoblasts unknown; articulations subpellucid, ecorticated, slightly longer than diam. at the middle and lower, 0.5 times as long as diam. at the upper part of filaments; siphons 5 in number, spirally or irregularly tubed at the middle, parallel at the other part of frond; tetrasporangia numerously formed on the upper parts of branchlets, arranged in a longitudinal series, slightly prominent, globose, about $75\mu$ diam., invisible in dividing manner; cystocarps and antheridia unknown. Colour brownish black. Specimens imperfectly or not adhering to paper in drying.

The frond of the present species is rather widely expanded to an irregular outline. It is characterized by possessing the five siphoned parts, zigzag and divaricate branching on the main filament. The tetrasporangial plant has not been reported in the Scotland plant, while in the material at hand it was found commonly. But the tetraspores were considerably indistinctive.

The specimens at hand accord fairly well with the descriptions and figures of *P. Richardsoni* given by HARVEY and BATTEN (l. c.). But the articulation seems to be shorter than that of foreign specimens.

SETCHELL and GARDNER established a new species *P. Marchantae* in the above-cited work. However, their specimen (Herb. Univ. Calif. No. 221052, Eureka, MARCHANT No. 52) and their descriptions and plates of it show that *P. Marchantae* seems to be identified with *P. Richardsoni*. HOLLENBERG reported "In general habit and in certain structural details *P. Marchantae* is similar to the Japanese species of *P. fragilis* SURINGAR as described by OKAMURA (1929)" in Polysiphonia on the Pac. Coast of North Amer. II. Polysiphonia (1944) p. 475. In the writer's opinion, however, *P. Marchantae* is more closely related to *P. Richardsoni* than to *P. fragilis* which seems to be a synonym of *P. forcipata*. *P. Richardsoni* can be distinguished from *P. forcipata* in having the zigzag, divaricate ramification and small terminal division.

### **Polysiphonia tapinocarpa** SURINGAR

Pl. XIII, 3, and Text-fig. 32.

Alg. Japon. (1870) p. 37, pl. 25, A, figs. 1–11; DE TONI, Syll, Alg. vol. 4 (1903) p. 908; OKAMURA, Nippon Kaisō Shi (1936) p. 835.

Japanese name: *Ke-itogusa.*

Hab.: Utsumi, Owari Prov.; Enoshima, Sagami Prov. (K. OKAMURA).

Distri.: Pacific coast of central districts in Japan.

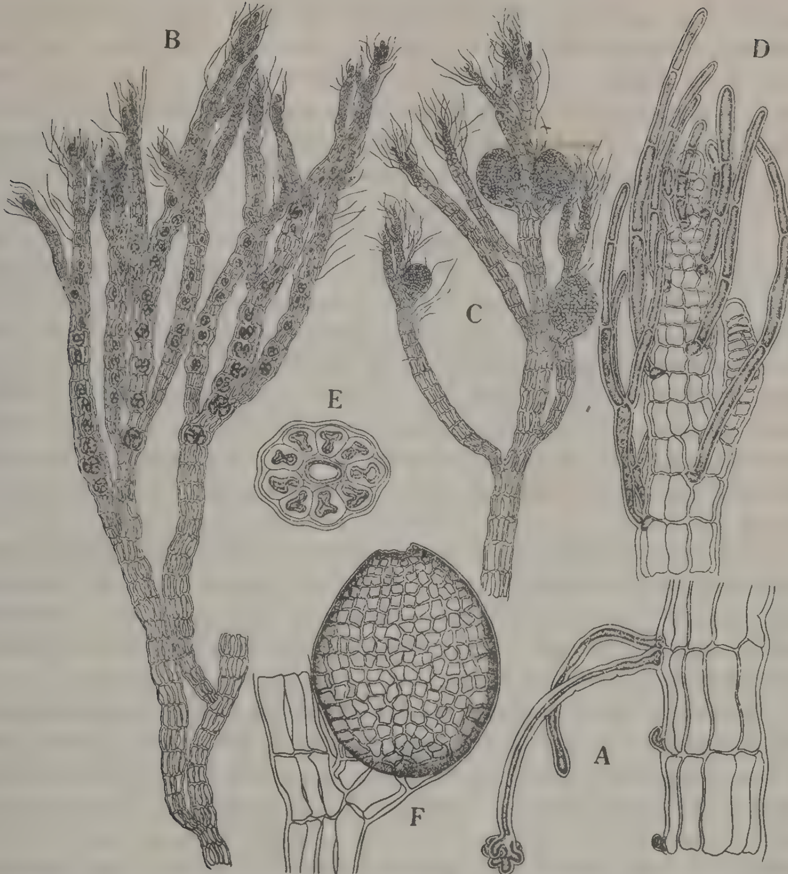



Fig. 32. *Polysiphonia tapinocarpa* SURINGAR. A. Rhizoids. ×60; B. Upper part of the tetrasporic branch. ×35; C. Upper part of the cystocarpic branch. ×35; D. Tip of the branch. ×350; E. Transverse section of the basal part of the frond. ×115; F. Cystocarp. × 115.

Fronds caespitose, entangled with each other, flaccid, mucous, fine, slender, elongate, 6.5–10 cm. high, assurgent from decumbent filaments; decumbent filaments about 315$\mu$ thick, robust, attached by numerous unicellular rhizoids; rhizoids arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, often more than one per segment, slender, elongate, 750–1050$\mu$ long, 45–60$\mu$ thick, sometimes provided with a discoid hapter at the end; erect filaments about 225$\mu$ thick near the base, with main axes distinct, distantly and laxly branched in subalternate or irregular manner; branches exo-

genously and sparsely arising at irregular intervals, often expanded to a pyramidal outline, slender, flexuose, patent, nude at the base, above set with penicillate branchlets; ultimate branchlets virgate, slender, narrow at the base, about 45$\mu$ thick near the middle, obtuse at the apices; trichoblasts very numerously issued near the apex, one on each segment, arising in a left hand spiral with ¼ divergence, straight, slender, simple or once forked, about 315$\mu$ long in the longest, leaving conspicuous scar-cells; branches not arising in connection with them; articulations pellucid, ecorticated, about 1.4 times as long as diam. near the basal, about 6 times at the middle, about 4 times at the upper part of erect filaments (almost equal to diam. near the middle part of branchlets); siphons 8–10 in number; tetrasporangia numerously arranged on the whole part of penultimate branchlets, placed in long longitudinal series, prominent, moniliformed, verrucose, globose, about 60$\mu$ diam., tripartitely divided; cystocarps scattered on the middle parts of penultimate branchlets, magnified, ovate, about 440–525×520–675$\mu$, pedicellate (1-celled), with a narrow ostiole at the apex. Colour brownish black. Specimens imperfectly adhering to paper in drying.

The present species grows on the upper side of rocks in sublittoral zone. It seems to be distributed rather widely in the warmer temperate waters of central districts in Japan. It is characterized by possessing dense trichoblasts near the apex of branches. The articulations are extremely elongated in the main axes, attaining to 1.6 mm. in length.

Materials at hand accord well with the description and figures of *P. tapinocarpa* SURINGAR from Japan given by the original author, except only for the following one point. In the original description SURINGAR reported the presence of cortical layer at the lower part of the frond. In the present materials, on the contrary, the writer has not met with any parts of the frond which were covered with a cortical layer. In the transverse section of the frond figured by SURINGAR (l. c. figs. 9–10), however, the cortical layer can not be seen at all. His figure (l. c. fig. 7) seems to show the distorted siphons only.

DE TONI referred this species to *Pterosiphonia bipinnata* (POST. et RUPR.) FALKENBERG (l. c.). But the former species much differs from the latter one in every respect.

## **Polysiphonia yonakuniensis** SEGI spec. nov.

Pl. XIII, 4, and Text-fig. 33.

Frondes mattas pulvinatas vel subglobosas formantes, tenues, paulum rigidae, parvae, 1.2–2 cm. altae, assurgentes ex filamentis prostratis repentibus; filamentis prostratis implicatis, robustis, 150–210$\mu$ crassis, per rhizoidea unicellularia affixis; rhizoideis ex angulo cellularum pericentralium irregulariter excrescentibus, per muros transversos abscissis, fere brevibus, robustis, 195–300$\mu$ longis, 45–52$\mu$ crassis, interdum discum terminalem ferentibus; filamentis erectis ex filamentis prostratis perpendiculariter ortis, 120–150$\mu$ crassis, subcylindraceis, paulum sursum attenuatis, cum nullis axibus principibus, pinnatim subdivisis, paucis ramulis adventiciis ornatis; ramis interdum exogene in 12–19 segmentis separatis, cum angulis acutis orientibus, elongatis, tenuibus, flexuosis, inferne subdichotomis sparsis ramosis, superne irregulariter et subpinnatim decompositis ramosis; ramulis intersparsis, adpressis, ca. 105$\mu$ crassis in parte media, virgatis, flexuosis, apice fere acutis et simplicibus vel patenter furcatis; trichoblastis numerosis prope partem superiorem ramulorum emittentibus, uno per segmentum, spiram laevam $\frac{1}{4}$ divergentem facientibus, tenuibus, elongatis, flexuosis, nonnulli-furcatis, 1275$\mu$ longis, deciduis, cicatricellulas conspicuas saepe relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis pellucidis, ecorticatis, equilongis diam. in parte media et superiore, paulum brevioribus in parte basali filamentorum erectorum (ca. 0.7 plo longioribus in parte media ramulorum); siphoniis 12–13; tetrasporangiis 13–16 longe longitudinaliter seriatis in totis partibus ramulorum ultimorum formatis, continuis et interruptis, saepe in lateribus abaxiale et adaxiale ramulorum ultimorum orientibus, prominentibus, verrucosis, globosis, ca. 60$\mu$ diam., tripartite divisis; cystocarpiis et antheridiis ignotis. Color violacea-brunneus. Specimina exsiccatione chartae imperfecte adhaerent.

Japanese name: *Yonakuni-itogusa.*

Hab.: Yonakuni Isl., Loochoo Isls. (T. TANAKA).

Fronds forming pulvinate or subglobose mats, fine, somewhat rigid, small, 1.2–2 cm. high assurgent from prostrate creeping filaments; prostrate filaments tangled, robust, 150–210$\mu$ thick, attached by unicellular rhizoids; rhizoids irregularly arising as outgrowths of the corner of the pericentral cells, cut off by cross walls, rather short, robust, 195–300$\mu$ long, 45–52$\mu$ thick, sometimes provided with a discoid hapter at the end; erect filaments arising perpendicularly from the prostrate filaments, 120–150$\mu$ thick, subcylindrical, slightly attenuated upwards, with no main axes, pinnately subdivided, provided with a few adventitious branchlets; branches sometimes arising exogenously in 12–19

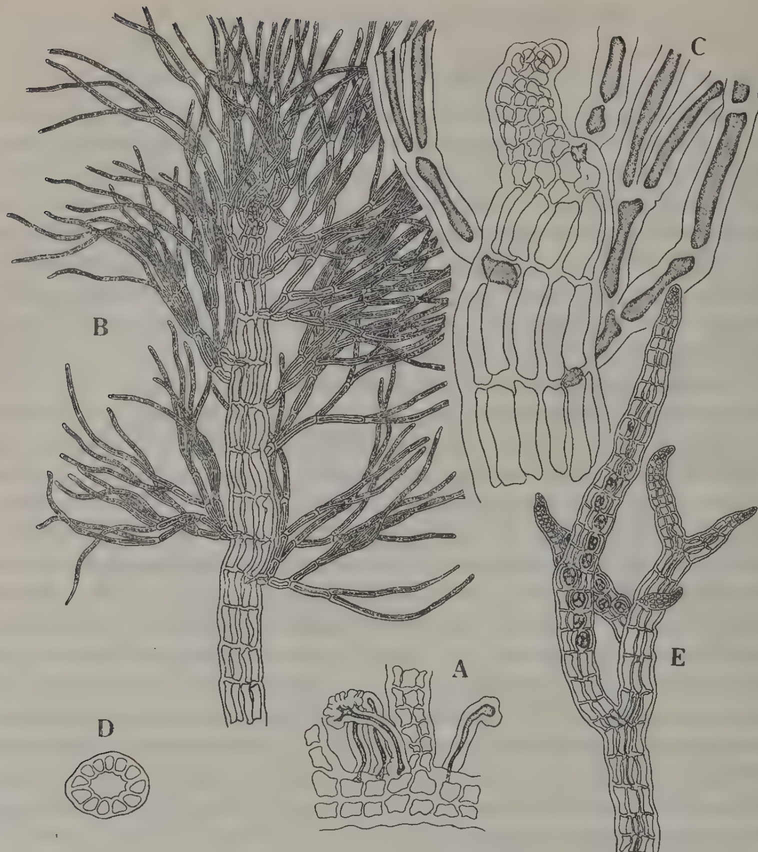



Fig. 33. *Polysiphonia yonakuniensis* SEGI. A. Rhizoids. ×60; B. Upper part of the branch. ×60; C. Tip of the branch. ×350; D. Transverse section of the basal part of the frond. ×115; E. Branchlet with tetraspores. ×60.

segments apart with rather acute angles, elongate, slender, flexuose, inferior sparsely branched in subdichotomous manner, superior irregularly and subpinnately branched in decomposite manner; branchlets interspersed, adpressed, about 105$\mu$ thick in the middle, virgate, flexuose, rather acute and simple or patently furcate at the apices; trichoblasts numerously issued near the upper part of branchlets, arising one per segment in a left hand spiral with $\frac{1}{4}$ divergence, slender, elongate, flexuose, several times forked; 1275$\mu$ long, deciduous,

often leaving conspicuous scar-cells; branches not associated with trichoblasts in origin; articulations pellucid, ecorticated, usually as long as diam. at the middle and upper, slightly shorter than diam. at the basal part of erect filaments (about 0.7 times at the middle part of branchlets); siphons 12–13 in number; tetrasporangia 13–16 arranged in a long longitudinal series, formed on the whole part of ultimate branchlets, continuous and interrupted, arising often in the abaxial and adaxial sides of ultimate branchlets, prominent, verrucose, globose, about 60$\mu$ diam., tripartitely divided; cystocarps and antheridia unknown. Colour dark violet brown. Specimens imperfectly adhering to paper in drying.

The new species is rather delicate, fine and small in the genus. In the substance, however, it is rather considerably rigid than flaccid. This species is usually characterized by possessing dense trichoblasts near the apex of branches. Their presence may be recognized with naked eyes even in dried specimens. They are placed commonly in a screw to the left with $\frac{1}{4}$ divergence of the circumference as far as could be observed. The writer has observed only once such tetrasporangia as two of which were transversely arranged in a row on the same segment.

In general this species shows evidently the close relationship to *P. opaca* (C. AGARDH) ZANARDINI in the various descriptions and figures (KUETZING, Tab. Phyc. vol. 13, 1863, pl. 47, figs. a–b; FALKENBERG, Rhodomelac., 1901, p. 120, pl. 21, figs. 10–11; DE TONI, Syll. Alg. vol. 4, 1903, p. 942; vol. 6, 1924, p. 401; BATTEN, The Genus Polysiphonia, in Journ. Linn. Soc. Bot. vol. 46, 1923, p. 293, pl. 23, figs. 36–37; BOERGESEN, Mar. Alg. Canary Isl. III, 1930, p. 104, figs. 42–44) and some foreign specimens (Phyc, Bor. Amer. Fas. 23, 1903, No. 1143; Herb. FELDMANN, algérie; Herb. HAUCK, Muggia; Herb. LENORMAND, Triest, Servola). From it, however, the difference in the origin of branches offers a criterion for discrimination. In *P. opaca* FALKENBERG noted that "steht die Natur der normalen Seitensprosse als seitlich verschobener Achselproducte der Blaetter zweifellos fest" (l. c. p. 121), while in *P. yonakuniensis* this is not the case, as noted above in the diagnosis. The branches arise independently, bearing no relation to trichoblasts in origin. Furthermore, the frond of this species is smaller, finer and composed of less siphons than that of *P. opaca*.

## **Polysiphonia porrecta** SEGI spec. nov.

Pl. XIV, and Text-fig. 34.

Frondes solitariae, elongatae, erectae, fere robustae et crassae, circumscriptione globosae expansae, 9–11.5 cm. altae; filamentis prope basim ca. 810$\mu$ crassis, tota parte fere equicrassis, cylindraceis, divaricatis, infra setaceis et rigidis, eximie patentibus, fulguraliter ramosis, sursum sensim propinque decompcsito-dichotome ramosis, terminaliter in angulis acutis tenuiter multi ramulosis; ramis primariis, nunc cum ramis subsecundis in axillis rotundatis nunc compluribus locis cum ramis trichotomis ornatis; ramis intervallis irregularibus late orientibus, infra nudis, supra sensim anguste axillaribus et subfastigiatim ramosis, in media parte per rhizoidea inter se continentibus; ramulis flaccidis, tenuibus, virgatis, apice obtusis; trichoblastis abundanter prope apicem ramorum sterilium emittentibus, uno per segmentum spiram laevam $\frac{1}{4}$ divergentem facientibus, 3 furcatis, 225–300$\mu$ longis, deciduis, cicatricellulas relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis opacis, infra corticatis (ecorticatis supra), ca. 0.5 plo diam. longioribus in parte basali et superiore, ca. 2 plo in parte media filamentorum; siphoniis basi 5, in parte media 7–8, in superiore filamentorum 6; tetrasporangiis paucis in ramulis adventiciis brevibus formatis, eximie prominentibus, solitariis, maximis, globosis, 150–225$\mu$ diam., tripartite divisis; cystocarpiis paulum in ramis proliferis vel in partibus superioribus ramulorum adventiciorum breviorum sparsis, late ovatis, 480–500×525–600$\mu$, brevissime pedicellatis, cum carposporis magnis. Color fusco-nigrescens. Specimina exsiccatione chartae non adhaerent.

Japanese name: *Naga-itogusa*.

Hab.: Henashi, Mutsu Prov. (Y. SAKAI).

Fronds solitary, elongate, erect, rather robust and thick, expanded to a globose outline, 9–11.5 cm. high; filaments about 810$\mu$ thick near the base, almost equal thick in each part, cylindrical, divaricate, below setaceous and stiff, very patent, branched in a zigzag form, upwards gradually closely branched in a decomposito-dichotomous manner, terminated in many slender branchlets with acute angles; primary branches sometimes provided with subsecund branches in round axils, sometimes furnished with trichotomous branches here and there; branches widely arising at irregular intervals, nude downwards, upwards gradually narrow axils and branched in subfastigiate manner, connected to each other by rootfibres emitting from the middle portion; branchlets flaccid, slender, virgate, obtuse at the apex; trichoblasts abundantly developed near the apex of sterile branches, one on each segment, arising in a left hand

spiral with ¼ divergence, 3 forked, 225–300$\mu$ long, deciduous, leaving scar-cells; branches not connected with trichoblasts in origin; articulations opake, corticated below (ecorticated above), about 0.5 times as long as diam. at the basal and upper, about 2 times at the middle part of filaments; siphons 5 in number

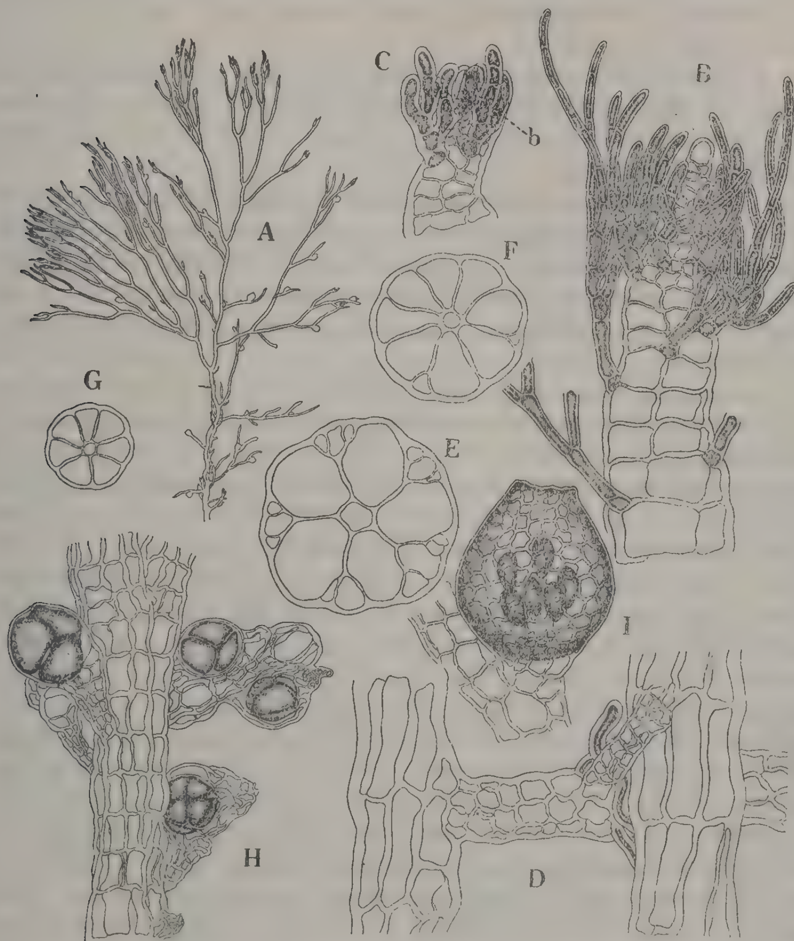



Fig. 34. *Polysiphonia porrecta* SEGI. A. Part of the cystocarpic frond. ×2; B. Tip of the branch. ×350; C. Tip of the branch showing "trichoblast unconnecting branch" (b); ×200. D. Part of the branches connected by rootfibres. ×35; E. Transverse section of the basal part of the frond. ×60; F. Transverse section of the middle part of the frond. ×60; G. Transverse section of the upper part of the frond. ×60; H. Tetraspores. ×60; I. Cystocarp. ×60.

at the base, 7–8 at the middle, 6 at the upper part of filament; tetrasporangia a few formed on the short adventitious branchlets, extremely prominent, solitary, very large, globose, 150–225$\mu$ diam., tripartitely divided; cystocarps scantily scattered on the proliferous branches or on the upper parts of short adventitious branchlets, broadly ovate, 480–500×525–600$\mu$, very shortly pedicellate, containing large carpospores. Colour brownish black. Specimens not adhering to paper in drying.

In Henashi fresh material the fronds are composed of 7–8 siphons and corticated in the middle, but at the base they indicate 5 siphons with cortical cells as noted above in the diagnosis. On the upper part of them the cortical cells are entirely wanting.

In another dried specimen collected by Mr. UEDA without nothing the locality the tetrasporic and cystocarpic individuals are associated with each other. There are two forms of cystocarp containing magnificent spores. One shows narrow globose, the other broadly ovato-globose as figured. The tetraspores are very large and a few extremely prominent on the short adventitious branchlets.

In external appearance and the structure of the stem, the new species shows evidently a strong resemblance to *P. variegata* (C. AGARDH) ZANARDINI in the descriptions and figures given by HARVEY (Phyc. Brit. 1846–51, pl. 155), KUETZING (Tab. Phyc. vol. 13, 1863, pl. 81, figs. d-f), THURET and BORNET (Etud. Phycol. 1878, p. 86, pl. 42), DE TONI (Syll. Alg. vol. 4, 1903, p. 922; vol. 6, 1924, p. 398), BOERGESEN (Mar. Alg. of Dan. West. Ind., vol. 2, 1915–1920, p. 270, figs. 246–266; Ind. Rhodophyc. IV, 1934, p. 26), BATTEN (The Genus Polysiphonia, in Journ. Linn. Soc. Bot. vol. 46, 1923, p. 307, pl. 25, figs. 74–76), TAYLOR (Mar. Alg. Northeast. coast of North Amer. 1937, p. 370, pl. 57, figs. 6–10) and in the American specimens (Woods Hole, Mass.; Orient, Long Island, Dupli. Herb. MRS. M. A. BOOTH, Distri. New York Bot. Gard.; Phyc. Bor. Amer. Fas. 5, 1896, No. 245, Fas. 13, 1899, No. 639). In the mode of branching, however, this alga differs fundamentally from *P. variegata.* According to FALKENBERG (in ENGLER and PRANTL., Nat. Pflanzenfam. 1897, I Teil, 2, Abt., p. 439, fig. 246. E) and BOERGESEN and TAYLOR (1. c.), in the foreign plant the branchlets are formed laterally at the base of the trichoblasts, but in Japanese plant this is not the case. All branches occur independently without a relationship to the trichoblasts. The writer also ascertained the former's fact in the foreign specimen. In the present specimens the fronds are branched rather regularly in a decomposito-dichotomous manner at the upper part of them and terminated in virgate branchlets which are not so densely tufted as those of the other foreign specimens.

As well as European species of *P. variegata,* the fronds in the Japanese

ones are distinctly corticated at the middle and basal parts of them, although BOERGESEN and TAYLOR (1. c.) reported the absence of cortical cells in American ones. So the writer put this species into corticate-group of the genus instead of ecorticate-group, to the contrary of DE TONI's classification (1. c.) on ***P. variegata.***

## **Polysiphonia Brodiaei** (DILLWYN) GREVILLE

Pl. XV, 1

In HOOKER "Br. Fl. vol. 2, p 328"; HARVEY, Phyc. Brit. (1846–51) pl. 105; KUETZING, Spec. Alg. (1849) p. 827; Id., Tab. Phyc. vol. 14 (1864) pl. 1, figs. d-f; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 993; Id., Florid. Morphol. (1879) pl. 33, fig. 16; KJELLMAN, Alg. Arc. Sea (1883) p. 120; HAUCK, Meeresalg. (1885) p. 237; BUFFHAM, On antheridia (1893) p. 298; DE TONI, Syll. Alg. vol. 4 (1903) p. 947, vol. 6 (1924) p. 402; KYLIN, Algenfl. schwed. Westkueste (1907) p. 143; Id., Rhodo. schwed. Westkueste (1944) p. 84; MAZZA, "Saggio n. 298"; BATTEN, The Genus Polysiphonia (in Journ. Linn. Soc. Bot. vol. 46, 1923) p. 303, pl. 24, figs. 61–63.

Syn. ***Conferva Brodiaei*** DILLWYN, "Brit. Conf. (1802–1809) pl. 107; ENGL., Bot. pl. 2589."

Syn. ***Hutchinsia Brodiaei*** LYNGBYE, Hydro. Dan. (1819) p. 109, pl. 33; C. AGARDH, Syst. Alg. (1824) p. 154; Id., Spec. Alg. vol. 2 (1828) p. 63.

Syn. ***Grammita Brodiaei*** BONNEMAISON, "Hydro. loc. (1822) p. 31."

Syn. ***P. polycarpa*** KUETZING, Phyc. Gen. (1843) p. 426; Id., Spec. Alg. (1849) p. 827; Id., Tab. Phyc. vol. 14 (1863) pl. 2, figs. e-g.

Syn. ***P. callitricha*** KUETZING, Phyc. gen. (1843) p. 427; Id., Spec. Alg. (1849) p. 827; Id., Tab. Phyc, vol. 14 (1864) pl. 2, figs. a-d; J. AGARDH, Spec. Alg. vol. 2 (1863) p. 1071.

Japanese name: ***Ō-itogusa*** (nov.).

Hab.: Oshoro, Hokkaidō (K. YENDO).

Distri.: Faroe Isl., Norway, North Atlantic Ocean; Gallia; England; Tingin Africa, Sicily Isl., Mediterranean Sea; Westcoast of Sweden.

Fronds widely expanded to semi-globose or pyramidal outline, elongate, robust, cartilaginous, 7–9 cm. high; filaments about 675$\mu$ thick near the base, gradually attenuated upwards, pinnately branched in a decomposite manner, with distinct main axes divided into several, long, simple, linear-lanceolate branches, covered with some minute adventitious branchlets scatteringly;

branches alternately or oppositely arising in wide angles, the lowest in almost right angles with stem, the rest divaricate and gradually narrow axils upwards, virgate, issuing numerous branchlets in a fastigiate manner; branchlets multifield, irregularly dichotomous, fasciculato-pennicillate, assuming an ovate outline; trichoblasts scantily arising near the apex of branches; articulations opake, corticated below, about 0.6 times as long as diam. at the basal, about 1.2 times at the middle, about 1.5 times at the upper part of filaments; siphons (6)-8 in number; tetrasporangia several produced on the middle parts of branchlets, discontinuous, prominent, relatively small globose, about 60$\mu$ diam., tripartitely divided: cystocarps and antheridia unknown. Colour blackish brown. Specimens adhering to paper in drying.

The present species is a handsome one in this genus, which is rather elongate, robust, densely ramified as noted above in the diagnosis. The frond is composed of 6-8 siphons at the lower part of the filaments and 4 ones at the upper part of them. The cortical layer can be seen clearly, but gradually diminishing in its number upwards.

This species accords rather well with the various descriptions and figures of *P. Brodiaei* in general. Above all, it is most nearly related to the KUETZING's figure (as *P. callitricha*, reported as a synonym of *P. Brodiaei* by DE TONI) and the British specimens. In the present specimens, however, the branchlets are generally not so densely tufted as those of the majority of the foreign specimens.

## **Polysiphonia fruticulosa** (WULFENI) SPRENGEL

Pl. XV, 2.

"Syst. Veget. IV, p. 350"; KUETZING, Spec. Alg. (1849) p. 836, Id., Tab. Phyc. vol. 14 (1864) pl. 28, figs. e-h; J. AGARDH, Spec. Alg. vol. 2 (1863) p 1028; ARDISSONE, Phyc. Mediter. 1 (1883) p. 393; HAUCK, Meeresalg. (1885) p. 241, fig. 99; BUFFHAM, "On antheridia (1888) p. 263"; FALKENBERG, Rhodomelac. (1901) p. 133, pl. 21, figs. 1-5; DE TONI, Syll. Alg. vol. 4 (1903) p. 950, vol. 6 (1924) p. 402; OLTMANNS, Morph. u. Biol. Alg. II (1922) p. 311, fig. 527, 5; BATTEN, The Genus Polysiphonia (in Journ. Linn. Soc. Bot. vol. 46, 1923) p. 305, pl. 22, fig. 2, pl. 25, figs. 77-79.

Syn. *Fucus fruticulosus* WULFENI, "in JACQ. Collect. p. 159, pl. 16; Id., Crypt. aquat. p. 56; ESPER, Icon. Fus. pl. 87; ENGL., Bot. pl. 1686; TURN., Hist. Fucor. pl. 227."

Syn. *Hutchinsia fruticulosa* C. AGARDH, Syst. Alg. (1824) p. 158.

Syn. *Rytiphloea fruticulosa* HARVEY, Phyc. Brit. (1846-51) pl. 220.

Syn. *Ceramium Wulfeni* ROTH, "Catal. bot. III (1806) p. 140."

Syn. *Grammita Wulfeni* BONNEMAISON, "Hydro. loc. (1822) p. 27."

Syn. *Hutchinsia Wulfeni* C. AGARDH, Spec. Alg. vol. 2 (1828) p. 95.

Syn. *P. Wulfeni* J. AGARDH, Alg. Med. (1842) p. 144; KUETZING, Spec. Alg. (1849) p. 836; Id., Tab. Phyc. vol. 14 (1864) pl. 28, figs. a–d.

Syn. *P. humilis* KUETZING, Spec. Alg. (1849) p. 837; Id., Tab. Phyc. vol. 14 (1864) pl. 29, figs. d–g.

Japanese name: *Harima-itogusa* (nov.)

Hab.: Kōbe and Akashi, Harima Prov. (K. YENDO).

Distri.: Atlantic coast of England; Canaria Isl.; Adriatic, Mediterranean Sea.

Fronds expanded to a semi or subglobose outline, dumose, erect, rather thick and rigid, cartilaginous, 4.7–6.5 cm. high; filaments about 800$\mu$ thick near the base, almost equally thick in every parts, without percurrent axes, subpinnately branched in a decomposito-dichotomous manner with wide angles, often issuing short, spine-formed adventitious branchlets throughout the frond; primary branches divided at the basal part of the stem, horizontal, opposite, the rest divided in rather wide angles, gradually narrow axils upwards, nude at the base, above much branched in an irregular or often pyramidal outline; branchlets irregularly arising in a subalternate or secund manner with wide angles, often subfastigiately arranged upwards; ultimate branchlets abbreviate, vulge, strongly constricted at the base, obtuse at the apex; trichoblasts unknown; articulations opake, corticated below, about 0.4 times as long as diam. near the basal, about 0.9 times at the middle, about 0.8 times at the upper part of filaments; siphons 8 in number, spirally curved; tetrasporangia a few arranged in short series on the middle parts of ultimate branchlets or upper parts of penultimate branchlets, extremely prominent, relatively large globose, about 90–112$\mu$ in diam., divided in tripartite manner; cystocarps and antheridia unknown. Colour almost blackish in drying. Specimens not adhering to paper in drying.

There are two dried specimens in the herbarium of YENDO. The fronds show dumose appearance and the ultimate branchlets are strongly constricted at the base as mentioned above in the diagnosis.

Our specimens accord rather well with *P. furticulosa* on the whole, especially in the KUETZING's figure (Tab. Phyc. l. c., as *P. humilis*, which was reported as a synonym of this species by DE TONI) and French specimens (Herb. LENORMAND, Cherbourg). But these Japanese ones do not coincide well with the other figures (KUETZING's Tab. Phyc. l. c. as *P. fruticulosa*; HARVEY's Phyc. Brit. l. c. as *R. fruticulosa*) and French specimens (Herb. LENORMAND, Côte atlantique la Normandie, ex herb. CHAUVIN), which are provided with

diffused stems and clothed with alternate, short, multified ramuli at a wide angle. But this difference seems to be only a matter of individual variation.

### **Polysiphonia notoensis** SEGI spec. nov.

Pl. XVI, 1, and Text-fig. 35.

Syn. *P. cancellata* (non HARVEY) YENDO, Notes on Alg. New to Japan IV (Bot. Mag. Tōkyō, vol. 30, 1916) p. 61; OKAMURA, Nippon Kaisō Shi (1936) p. 836.

Frondes cristas formantes, epiphyticae in alias algas, semiglobose expansae, fruticosae, robustae, crassae, 5.5-10 cm. altae; filamentis 600-825$\mu$ crassis prope basim, cylindraceis, sulcatis, cum nullis axibus principibus, prominentibus in nodis, sursum sensim attenuatis, irregulariter et pinnatim decomposito-dichotomis ramosis, patentibus, per totam frondem ramulis adventiciis numerosis ornatis, basi per rhizoidea unicellularia affixis; rhizoideis ex cellulis corticatis basi excrescentibus, plerumque terminaliter ramosis, tenuibus, elongatis, 450-1050$\mu$ longis, 60-75$\mu$ crassis, discum terminalem non ferentibus; ramis infimis prope basim quoquoversum rectangulariter egredientibus, verticillatis, reliquis late angulariter subsecundis orientibus, elongatis, flexuosis; ramulis saepe in intervallis irregularibus, (10)-15-(27) segmentis separatis, tenuibus; ramulis ultimis mollibus, lanceolato-subulatis, apice fere acutis; trichoblastis interdum abundanter prope apicem ramulorum emittentibus, uno per segmentum, spiram laevam $\frac{1}{4}$ divergentem facientibus, 1-2 furcatis, 600-900$\mu$ longis, deciduis, cicatricellulas inconspicuas relinquentibus; ramis cum trichoblastis in origine non conjunctis; articulis opacis, infra corticatis (supra ecorticatis), equilongis diam. in parte media et inferiore, 0.7 plo longioribus in parte superiore filamentorum (ca. 0.5 plo longioribus in parte media ramulorum); siphoniis 7-9; tetrasporangiis numerosis et spiraliter seriatis in partibus superioribus ramulorum, plerumque continuis, nunc fere non prominentibus, nunc eximie prominentibus, relativiter parvis, globosis, ca. 135$\mu$ diam., tripartite divisis; cystocarpiis numerosis in ramulis sparsis, late ovatis, 525-675 $\times$ 620-720$\mu$, apice ostiolo angusto donatis. Color brunneus vel fere nigrescens. Specimina exsiccatione chartae adhaerent.

Japanese name: Noto-itogusa.

Hab.: Shibagaki and Wajima, Noto Prov.; Nezugaseki, Uzen Prov. (Y. YENDO); Syōbuta, Rikuzen Prov. (Y. YENDO); Ōma, Mutsu Prov. (Y. YENDO); Hakuhi, Noto Prov. (K. OKAMURA).

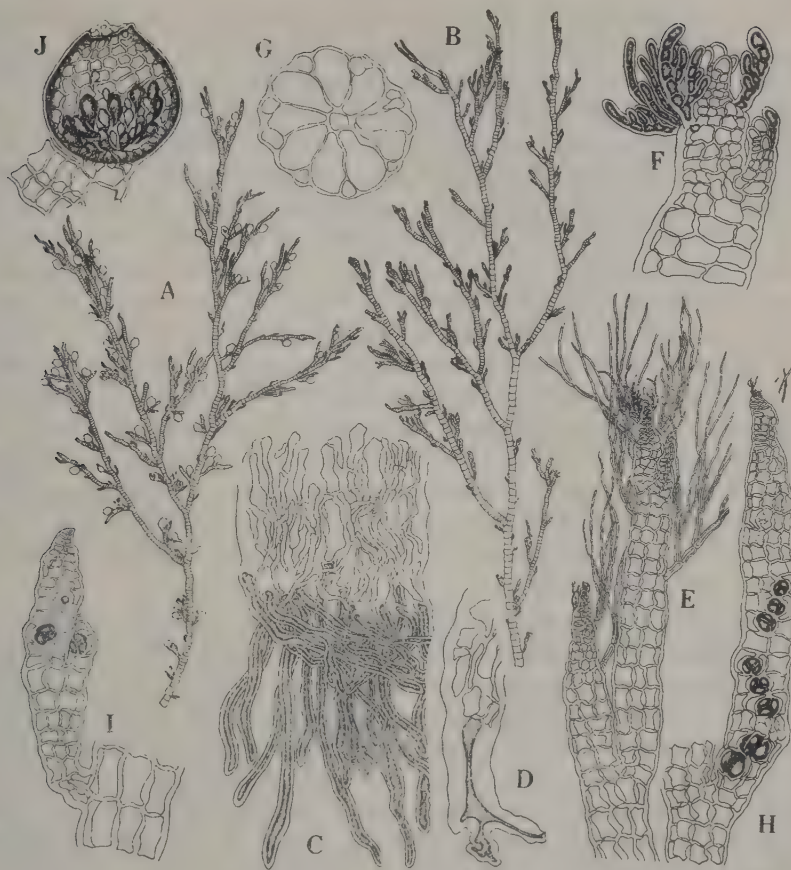



Fig. 35. *Polysiphonia notoensis* SEGI. A. Upper part of the cystocarpic branch. ×2.5; B. Upper part of the tetrasporic branch. ×2.5; C. Rhizoids. ×60; D. First rhizoid. ×60; E. Upper part of the branchlet. ×35; F. Tip of the branch. ×35; G. Transverse section of the basal part of the frond. ×35; H. Branchlet with tetraspores. ×35; I. Tetraspores. ×35; J. Cystocarp. ×35.

Fronds forming tufts, epiphytic on other algae, expanded to semiglobose outline, bushy, robust, thick, 5.5–10 cm. high; filaments 600-825$\mu$ thick near the base, cylindrical, sulcate, with no main axes, prominent at the nodes, gradually attenuated upwards, irregularly and pinnately branched in a decomposito-dichotomous manner, patent, provided with numerous adventitious branchlets throughout the frond, attached by unicellular rhizoids at the base; rhizoids

arising as outgrowths of the cortical cells at the base, often branched near the end, slender, elongate, 450–1050μ long, 60–75μ thick, provided with no discoid hapter at the end; branches the lowest issuing in every direction with right angles near the base, verticillate, the rest subsecundly arising with wide angles, elongate, flexuose; branchlets often secundly arising at irregular intervals, (10)–15–(27) segments apart, slender; ultimate branchlets soft, lanceolato-subulate, rather acute at the tip; trichoblasts sometimes abundantly developed near the apex of branchlets, arising one per segment in a left hand spiral with $\frac{1}{4}$ divergence, 1–2 forked, 600–900μ long, deciduous, leaving inconspicuous scar-cells; branches not associated with trichoblasts in origin; articulations opake, corticated below (ecorticated above), as long as diam. at the middle and lower part, 0.7 times at the upper part of filaments (about 0.5 times at the middle part of branchlets); siphons 7–9 in number; tetrasporangia numerously and spirally seriate on the upper part of branchlets, usually continuous, sometimes almost non prominent, sometimes very prominent, relatively small, globose, about 135μ diam., tripartitely divided; cystocarps numerously scattered on the branchlets, broadly ovate, 525–675×620–720μ, with narrow ostiole at the apex. Colour dark brown or almost black. Specimens adhering to paper in drying.

The new species was found growing on the stem of *Sargassum*, forming a tuft. The abundant materials from Shibagaki show such characters as mentioned in the above diagnosis, but those from Wajima are dichotomously branched without adventitious branchlets on the filament and almost equally thick in every part of it. The basal cells are hexagonal in shape and arranged in cancellated form. The rhizoids are often branched near the end. They are produced from the cortical cells, but the first originates from the lowermost cell of the young plant as shown in Figure 35, D. The reproductive organs are formed also on the adventitious branches which are arising in an endogenous manner.

In outward appearance the present alga shows a strong resemblance to *P. cancellata* HARVEY described and figured by HARVEY (Ner. Austr. 1847, p. 51, pl. 15) and KUETZING (Tab. Phyc. vol. 13, 1863, pl. 66, figs. a–c). Furthermore, as compared with the Australian specimen (Herb. LENORMAND, Port Phillip, Legit. F. MUELLER) and its photograph (Herb. Univ. Calif. No. 431076, Portland Bay, F. MULLER) of *P. cancellata*, *P. notoensis* is very similar to it in outward appearance. But the present species differs in the following two anatomical characters. In the first place, in *P. cancellata* the cortical cells never can be seen at all, as noted by HARVEY, while in this species this is not the case, as expressed a doubt by YENDO (l. c.) also. The writer also ascertained this fact in Australian specimens (l. c.). In the second place, this plant differs from it

in the type of origin of the branches. In foreign species they arise on the bases of certain of the trichoblasts (OKAMURA, Nippon Kaisō Shi, 1936, p. 813), while they certainly do not on this Japanese one.

In the herbarium of YENDO and OKAMURA the writer compared the present specimen with YENDO's specimens (Nezugaseki, Uzen Prov.; Syōbuta, Rikuzen Prov.; Oma, Mutsu Prov.) and OKAMURA's ones (Hakuhi, Noto Prov.) called *P. cancellata* and came to the conclusion that this specimen is exactly the same as their ones, which should be identified with ***P. notoensis***.

## Polysiphonia crassa OKAMURA

Pl. XVI, 2, and Text-fig. 36.

Icon. Japan. Alg. vol. 6 (1929) p. 6, pl. 254; Id., Nippon Kaisō Shi (1936) p. 837.

Japanese name: *Futo-itogusa.*

Hab.: Enoshima, Sagami Prov. (S. ARASAKI, K. OKAMURA); Susaki, Tosa Prov. (T. TANAKA).

Distri.: Central and southern Pacific coasts of Japan.

Fronds solitary or a few tufted, epiphytic on other algae, fleshy, rather rigid, erect, thick, 3.5-4.2 cm. high; filaments about 675μ thick near the base, of equal thickness for each part, slightly tapering upwards to a bluntish apex, cylindrical, divaricated in a dichotomo-alternate manner; branches widely parted with broad and round axils, not constricted at the base, sometimes forcipate at the apex; trichoblasts unknown; articulations invisible, corticated throughout the filament, 0.3-0.5 times as long as diam.; siphons 10-11 in number; tetrasporangia a few seriate on the tufted, fusiformed, torulose, short branchlets, prominent, small globose, about 60μ diam., invisible in dividing manner; cystocarps sitting on the side of branchlets, aggregated, almost sessile, globose, about 450μ diam., or broadly ovate, 375×345μ, with a wide ostiole at the apex. Colour dark redish brown. Specimens not adhering to paper in drying.

The present species was found growing on the stem of *Sargassum* with *Ceramium Crassum* OKAMURA. Some dried specimens are at hand. In the present materials the hypha-like filament can be seen clearly in the transverse section of the basal part of the frond, but upwards it is diminishing in its number. The frond shows numerous pericentral cells and in the lower part of it some of them give off small elongated cells downwards along the frond. The cystocarps are often aggregated and placed on the short branchlets laterally as if supported by the bract.

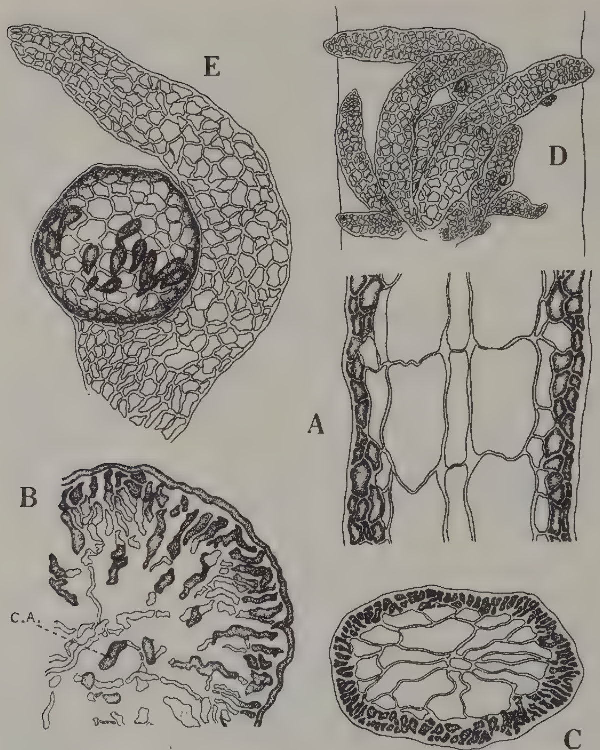



Fig. 36. *Polysiphonia crassa* OKAMURA. A. Longitudinal section of the frond. ×60; B. Transverse section of the basal part of the frond showing hypha-like filaments. ×30; C. Transverse section of the basal part of the frond. ×30; D. Stichidia. ×35; E. Cystocarp. ×60.

Being compared with the type specimen of *P. crassa* OKAMURA (Herb. OKAMURA), the present alga agrees well with it in every characteristic. OKAMURA figured the trichoblasts on the apex of the male plants distinctly, although the writer has not been able to observe them.

# VI. Index of the Species, Forms and Synonyms (*Italics*)

# PLATES

## PLATE 1

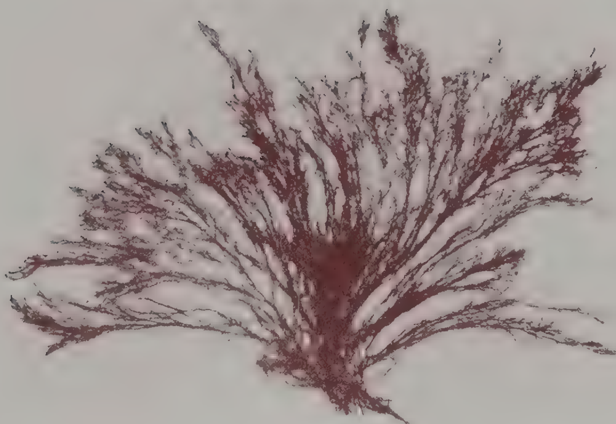
1. *Polysiphonia fibrata* HARVEY. × 1.

    The specimen from Clare Island, Ireland.

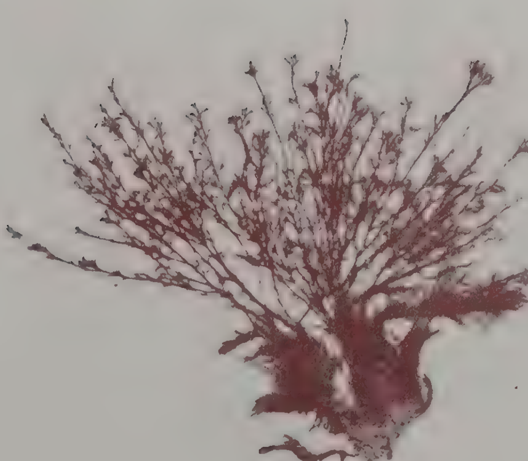
2. *Polysiphonia fibrata* HARVEY. × 1.

    The specimen from Durlstone Head, England.

PLATE 1



1



2

## PLATE 2

1. *Polysiphonia violacea* (ROTH) GREVILLE. Slightly reduced.
   The specimen from Atlantic coast of France.
2. *Po'ysiphonia Kampsaxii* BOERGESEN. × 1.
   Habit of the plant.

PLATE 2



1



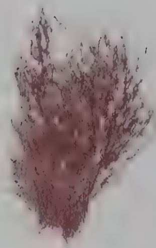
2

## PLATE 3

1. *Polysiphonia codiicola* Zanardini. × 1.
   Habit of the plant.
2. *Polysiphonia obsoleta* Segi. × 1.
   Type specimen.
3. *Polysiphonia Tokidae* Segi. × 1.
   Type specimen.
4. *Polysiphonia Tokidae* Segi. × 1.
   Habit of the plant.
5. *Polysiphonia pulvinata* J. Agardh (?). × 1.
   Habit of the plant.
6. *Polysiphonia subtilissima* Montagne. × 1.
   Habit of the plant.
7. *Polysiphonia scopulorum* Harvey. × 1.
   Habit of the plant.
8. *Polysiphonia Savatieri* Hariot. × 1.
   Habit of the plants.

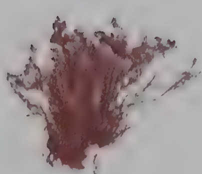
PLATE 3

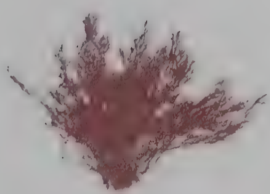

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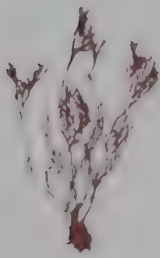

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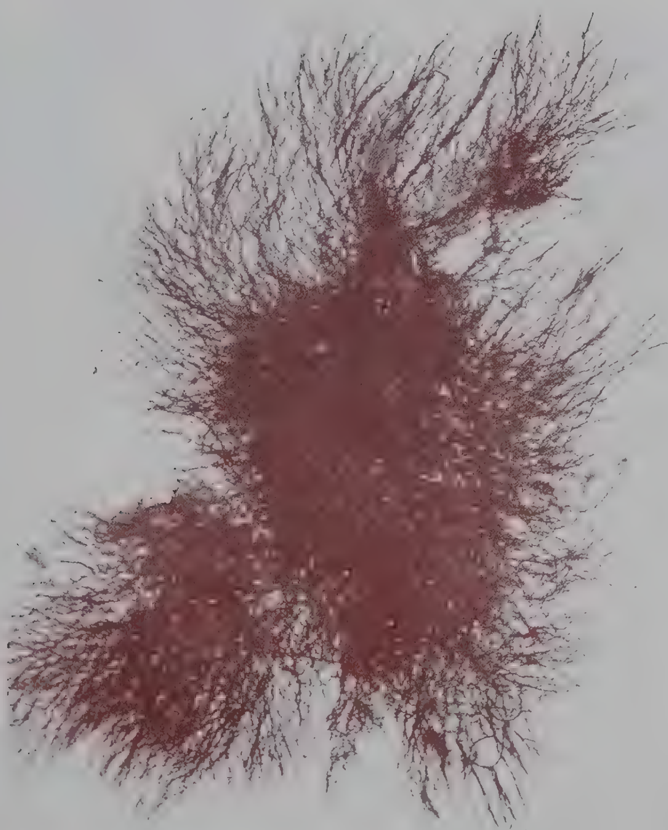

8

## PLATE 4

*Polysiphonia tongatensis* HARVEY. × ca. $\frac{4}{5}$

Habit of the plant.

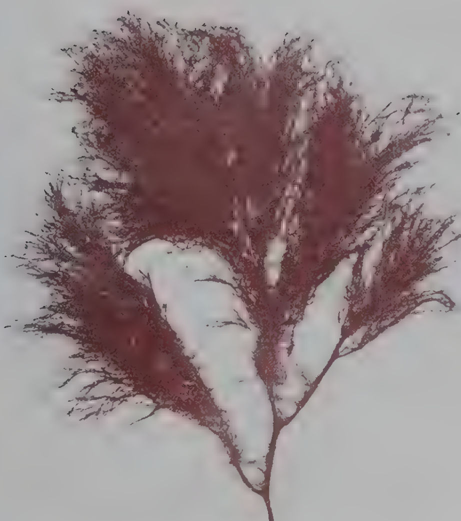
PLATE 4



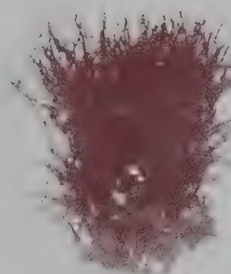
# PLATE 5

1. *Polysiphonia tongatensis* HARVEY var. (?) × ca. $\frac{4}{5}$.
   Epiphytic on other red alga.
2. *Polysiphonia ferulacea* SUHR. × 1.
   The specimen from Samani.
3. *Polysiphonia ferulacea* SUHR. × 1.
   The specimen from Nomosaki.

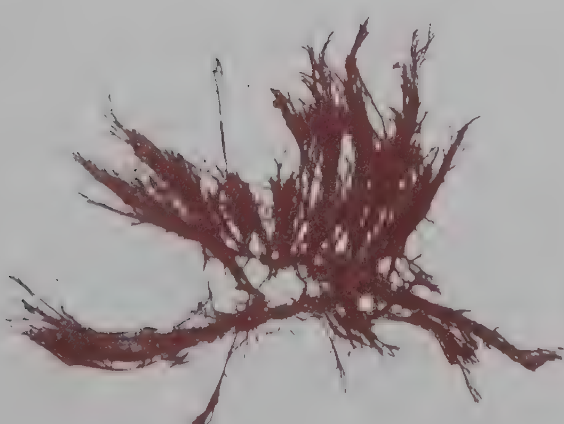
PLATE 5



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# PLATE 6

1. *Polysiphonia Yendoi* SEGI. × 1
   Type specimen.

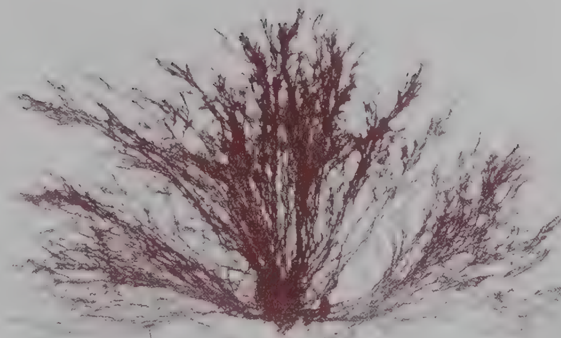
2. *Polysiphonia Yendoi* SEGI. × 1.
   The specimen from Oshoro.

3. *Polysiphonia spinosa* (AG.) J. AGARDH. × $\frac{5}{6}$.
   Habit of the plant.

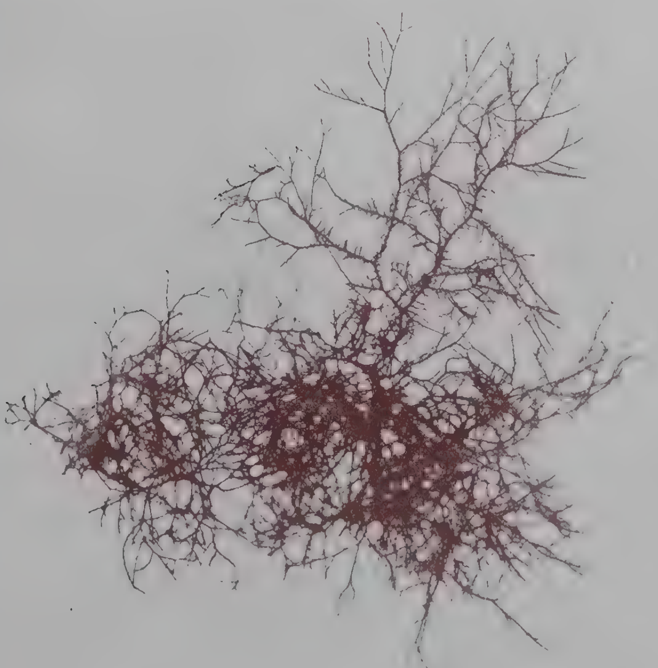
PLATE 6



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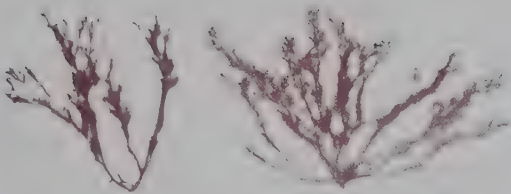


3

# PLATE 7

1. *Polysiphonia Harlandii* HARVEY. × 1.
   Habit of the plants.
2. *Polysiphonia decumbens* SEGI. × 1.
   Epiphytic on *Chondria*.
   Type specimen.
3. *Polysiphonia nipponica* SEGI. × 1.
   Type specimen.

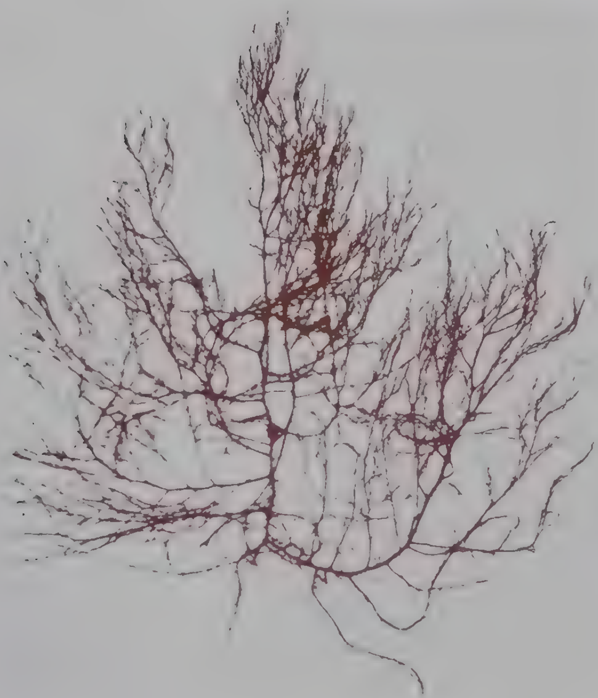
PLATE 7



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# PLATE 8

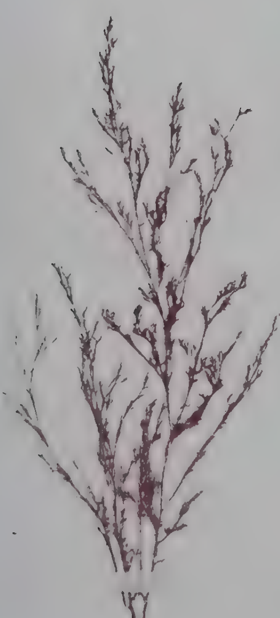
1. *Polysiphonia nipponica* SEGI. × 1.
   The specimen from Komi.

2. *Polysiphonia novae-angliae* TAYLOR. × $\frac{5}{6}$.
   Habit of the plant.

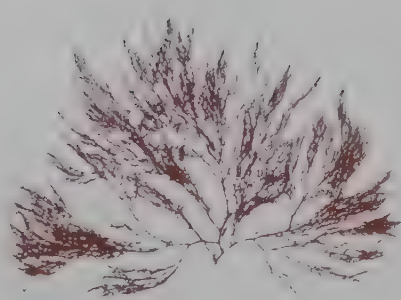
3. *Polysiphonia japonica* HARVEY. × 1.
   Habit of the plant.



1



2



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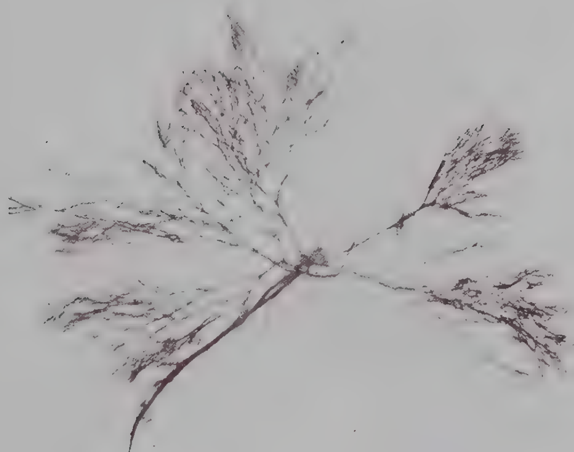
# PLATE 9

1. *Polysiphonia akkeshiensis* SEGI. × 1.
   Type specimen.

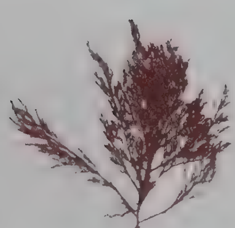
2–3. *Polysiphonia akkeshiensis* SEGI. × 1.
   The specimens from Kojima.

4. *Polysiphonia abscissa* HOOKER et HARVEY. × 1.
   Habit of the plant.

PLATE 9



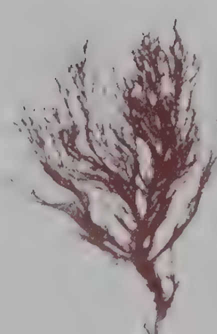
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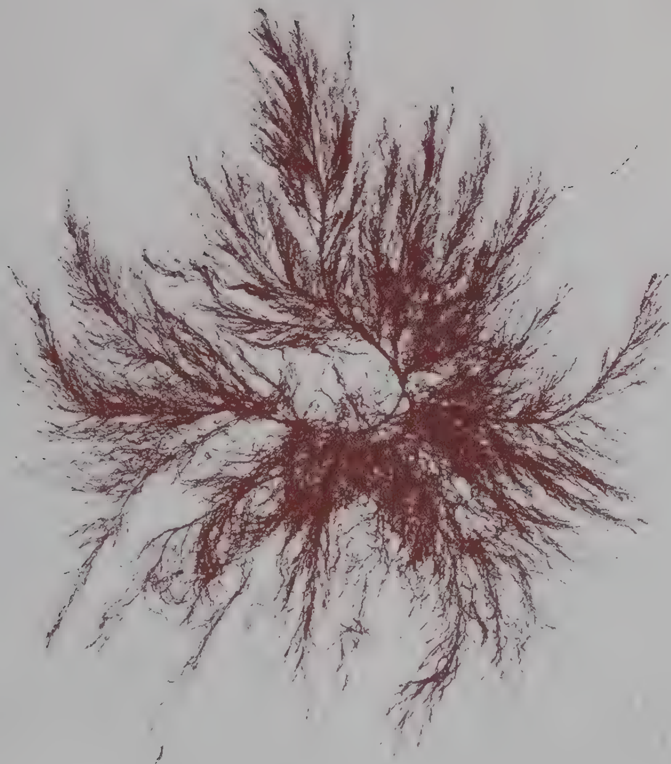


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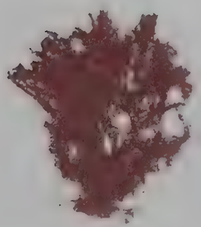
## PLATE 10

1. *Polysiphonia urceolata* (DILLWYN) GREVILLE. × ca. ½
   f. *typica* KJELLMAN.
   The specimen from Sakaehama.

2. *Polysiphonia urceolata* (DILLWYN) GREVILLE. × 1.
   f. *lepadicola* (LYNGBYE) SEGI.
   Habit of the plant.



1



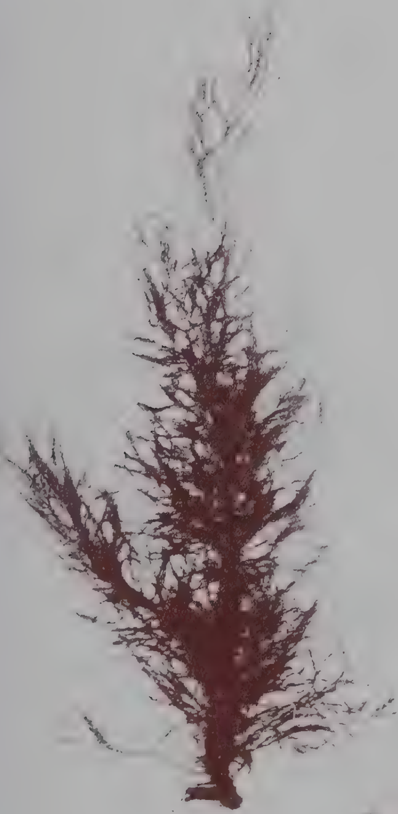
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# PLATE 11

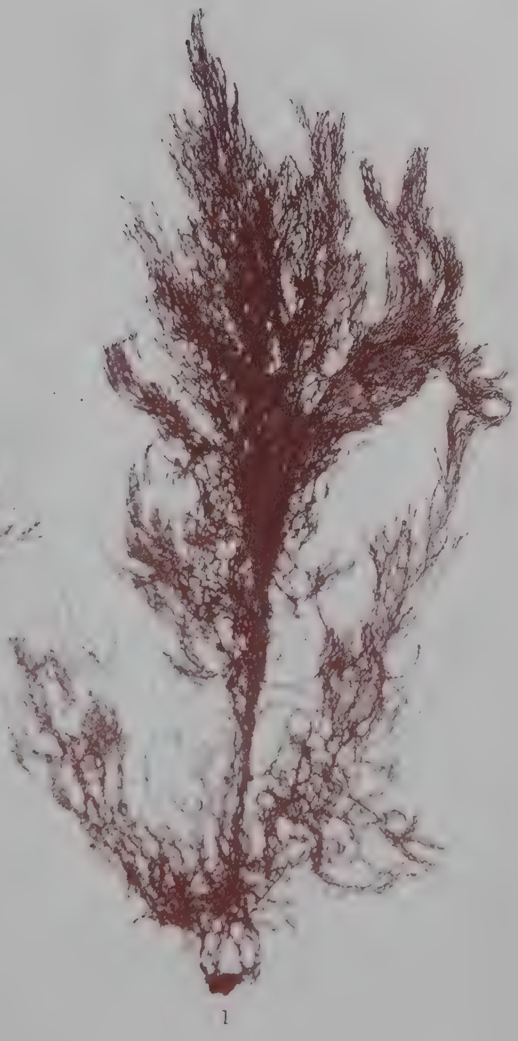
1. *Polysiphonia urceolata* (Dillwyn) Greville. $\times$ 1.
   f. *patens* (Dillwyn) Harvey.
   The specimen from Shikotan Island.

2. *Polysiphonia Morrowii* Harvey. $\times$ ca. $\frac{5}{8}$.
   Habit of the plant.

PLATE 11



2



1

# PLATE 12

*Polysiphonia senticulosa* HARVEY. $\times$ ca. $\frac{3}{5}$.
Habit of the plant.

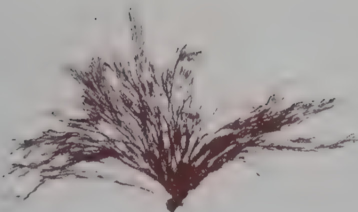
PLATE 12



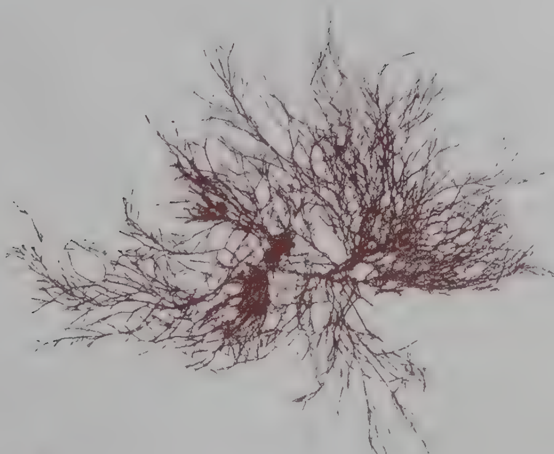
# PLATE 13

1. *Polysiphonia forcipata* HARVEY. × 1.
   Habit of the plant.
2. *Polysiphonia Richardsoni* HOOKER. × ca. $\frac{2}{3}$.
   Habit of the plant.
3. *Polysiphonia tapinocarpa* SURINGAR. × 1.
   Habit of the plant.
4. *Polysiphonia yonakuniensis* SEGI. × 1.
   Type specimen.

PLATE 13



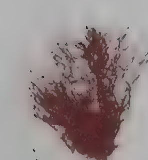
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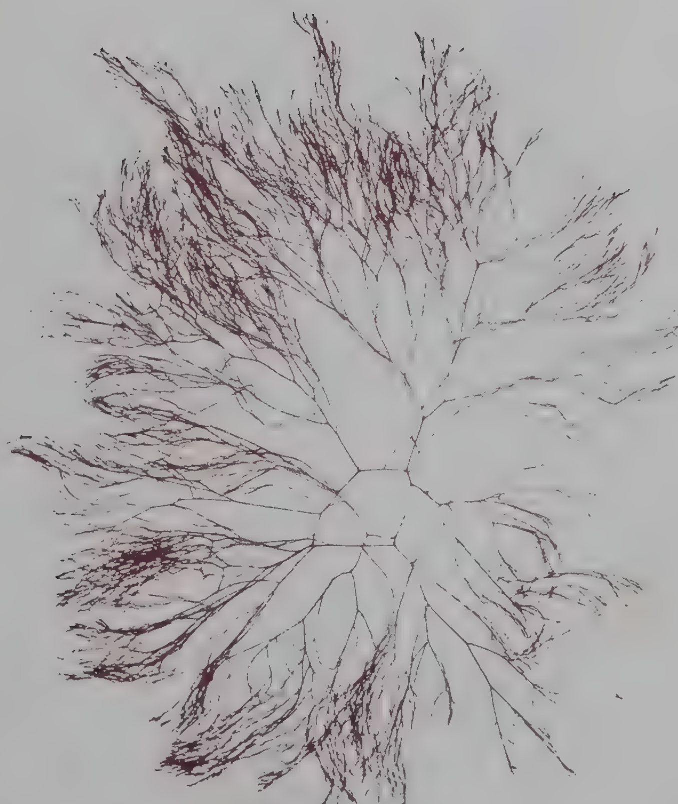


4

# PLATE 14

*Polysiphonia porrecta* SEGI. × ca. $\frac{3}{4}$.
Type specimen.

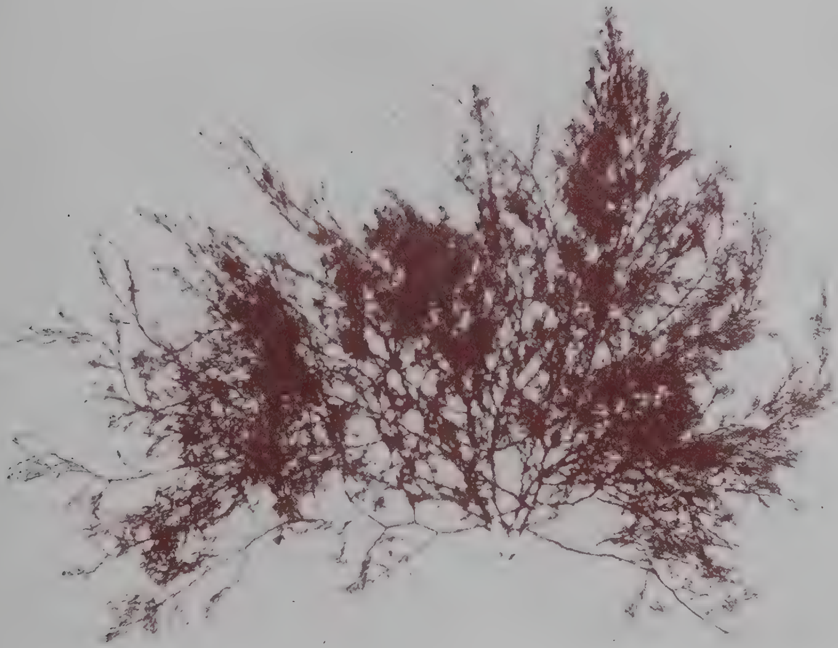
PLATE 14



## PLATE 15

1. *Polysiphonia Brodiaei* (Dillwyn) Greville. × 1.
   Habit of the plant.
2. *Polysiphonia fruticulosa* (Wulfeni) Sprengel. × 1.
   Habit of the plant.

PLATE 15



1



2

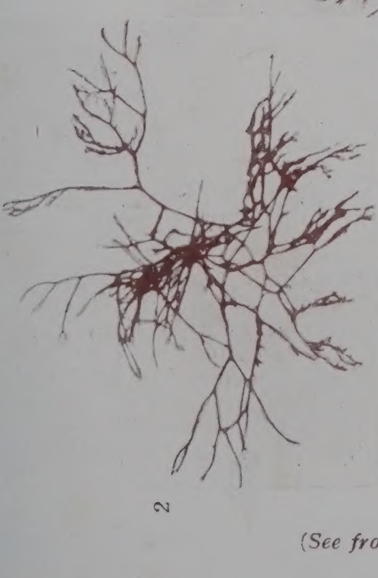
## PLATE 16

1. *Polysiphonia notoensis* SEGI. × 1.
   Type specimen.
2. *Polysiphonia crassa* OKAMURA. × 1.
   Habit of the plant.

PLATE 16



1



2

*(See from the right side)*

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All communications relating to this Journal should be addressed to the Dean of the Faculty of Fisheries.

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